COMPTES RENDUS

(DOKLADY)

DE L'ACADÉMIE DES SCIENCES DE L'URSS

NOUVELLE SÉRIE

1936

IMPERIAL MYCOLOGICAL
26 NOV 1936
INSTITUTE

VOLUME IV

№ 2

ÉDITION DE L'ACADÉMIE DES SCIENCES DE L'URSS
MOSCOU

AVIS AUX AUTEURS

Les «Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS» sont publiés en livraisons, neuf numéros formant un volume d'environ 500 pages pourvu de sa table des matières.

Les «Comptes Rendus de l'Académie des Sciences de l'URSS» publient des communications préalables des auteurs précisant le contenu essentiel des travaux plus volumineux en préparation. Ces articles, ne dépassant pas comme règle dix mille signes typographiques, sont donnés en l'une des trois langues: français, anglais, allemand. Ils embrassent les sciences mathématiques, physiques et naturelles et les aspects théoriques des applications techniques, reproduisant des résultats de recherches scientifiques actuellement en cours ou à peine achevées qui représentent les plus récentes acquisitions de l'investigation scientifique.

Les articles sont publiés dans la langue de l'original envoyé par l'auteur (français, anglais, allemand).

Les auteurs ont droit chacun à 25 extraits gratuits.

Les manuscrits doivent être adressés à la Rédaction de «Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS»—Moscou, oulitza Kuibyševa, 8.

COMPTES RENDUS

(DOKLADY)

DE L'ACADÉMIE DES SCIENCES DE L'URSS

NOUVELLE SÉRIE

4-me année

Paraissant tous les dix jours

COMITÉ DE RÉDACTION

A. Borissiak, de l'Académie, A. Fersman, de l'Académie, A. Richter, de l'Académie;
S. Wawilow, de l'Académie

1936

VOLUME IV (XIII)—№ 2 (106)

Moscou

TABLE DES MATIÈRES

MATHÉMATIQUES

J. Dubnov (Doubnoff) et **N. Efimov.** Sur les couples et faisceaux de réseaux 43

PHYSIQUE

M. M. Gurevič. Changement de la brillance du faisceau de rayons pendant la réfraction 47

N. Ivanova. Sur les parcours des particules constituantes des «gerbes» de rayons ultra-pénétrants 49

W. A. Osipov-King. Über eine neue Konstruktion von Polarisationsprismen 53

L. M. Schamovskij. Über den photographischen Elementarprozess in Ionenkristallen 57

CHIMIE

F. M. Šemiakin. On the Question of Periodical Reactions 63

A. Polesickij. On the Lower Bound of the Formation of the Mixed Crystals of the New Type 65

BIOCHIMIE

W. A. Deviatnin. Über eine chemische Methode zur Bestimmung des Vitamins B_1. 67

GÉOCHIMIE

O. E. Zviagincev and **E. L. Pisarževskaia.** On the Action of Sulphide Minerals on Solutions of Gold and Platinum Salts 73

GÈNÉTIQUE

A. I. Zuitin and **V. V. Ivanova.** The Data on the Structure of the Testes of Hybrids of Yak and Cattle 75

PHYSIOLOGIE VÉGÉTALE

M. Ch. Čhajlachian. New Facts in Support of the Hormonal Theory of Plant Development. 79

ZOOLOGIE

A. L. Behning. Kaspische Perakariden im Manytsch-Bassin. 85

E. M. Krochin and **F. V. Krogius.** The Lake Form of *Oncorhynchus nerka* from Lake Kronotsk, Kamchatka 89

G. M. Rall. Character of the Propagation of Certain Rodents as a Factor of Their Number in Nature 93

ZOOLOGIE EXPÉRIMENTALE

N. V. Nassonov, Member of the Academy. Influence of Various Factors on Morphogenesis Following Homotopical Subcutaneous Insertions of Cartilage in the Axolotl 97

N. V. Nassonov, Member of the Academy. Morphogenesis Following Heterotopical and Heteroplastical Insertions of Cartilage under the Skin of Axolotl 101

Imprimé par ordre de l'Académie des Sciences de l'URSS
Secrétaire perpétuel, membre de l'Académie **N. Gorbounov.**
Comité de Rédaction: **A. Borissiak,** de l'Académie, **A. Fersman,** de l'Académie, **A. Richter,** de l'Académie, **S. Wawilow,** de l'Académie.
Rédacteur en chef: A. Fersman.—Rédacteur: S. Bernstein

En composition: 23. IX. 1936.—En impression: 31. X. 1936. Nombre de feuilles d'imprimerie: 4—Nombre de caractères par feuille imprimée 65.000.—Pages 41—104. Format du papier 72×110 cm. Tirage 1 300. Moscou. Glavlit B—50712.—Numéro d'édition 434.—Numéro typographique 1237

Imprimerie № 16, Moscou. Trekhproudnij pereoulok, 9.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

MATHÉMATIQUES

SUR LES COUPLES ET FAISCEAUX DE RÉSEAUX

Par J. DUBNOV (DOUBNOFF) et N. EFIMOV

(Présenté par N. N. Lusin, de l'Académie, le 15. VI. 1936)

1. Étant donnée une surface $S(u^1, u^2)$, on peut attacher à chaque réseau bien déterminé par une équation différentielle $\varphi_{\alpha\beta} du^\alpha du^\beta = 0$ (où $\alpha, \beta = 1, 2$ sont les indices de sommation; $\varphi_{ij} = \varphi_{ji}$; $\operatorname{Det} \varphi_{ij} \neq 0$) le tenseur mixte Φ_k^i défini au signe près par la matrice

$$\begin{pmatrix} \Phi_1^1 \Phi_1^2 \\ \Phi_2^1 \Phi_2^2 \end{pmatrix} \equiv \frac{1}{\sqrt{\varphi_{12}^2 - \varphi_{11}\varphi_{22}}} \begin{pmatrix} -\varphi_{12} \varphi_{11} \\ -\varphi_{22} \varphi_{12} \end{pmatrix}.$$

Nous allons appeller ce tenseur le tenseur principal du réseau. Pour les deux réseaux $\underset{1}{\Phi_k^i}$ et $\underset{2}{\Phi_k^i}$ l'invariant

$$2h = \underset{12}{\Phi_\alpha^\beta} \underset{1}{\Phi_\beta^\alpha} \underset{2}{\Phi_\beta^\alpha} \tag{1}$$

a une signification géométrique simple: à chaque point de la surface le rapport anharmonique des quatre directions détérminées par les courbes de l'un et de l'autre réseau, est égal à

$$(\underset{12}{h} - 1) : (\underset{12}{h} + 1).$$

On peut aussi exprimer la liaison qui existe entre les tenseurs principaux des deux réseaux et l'invariant h par l'équation:

$$\underset{1}{\Phi_i^\alpha} \underset{2}{\Phi_\alpha^h} + \underset{2}{\Phi_i^\alpha} \underset{1}{\Phi_\alpha^h} = 2\underset{12}{h}\delta_i^h, \tag{2}$$

où δ_i^k désigne le tenseur unitaire.

Nous dirons que deux réseaux séparés (c'est-à-dire n'ayant pas de famille commune) sont en rapport anharmonique constant, si le rapport susdit des quatre directions est le même dans tous les points de la surface: $\underset{12}{h} = \text{const} \neq \pm 1$. En particulier, pour $\underset{12}{h} = 0$ les réseaux sont mutuellement harmoniques. La condition à laquelle doivent satisfaire en ce cas les tenseurs $\underset{1}{\Phi}$ et $\underset{2}{\Phi}$ peut être obtenu de (1) ou de (2).

2. Si la surface S est douée d'une connexion affine, la dérivation covariante (que nous désignerons dans ce qui suit par un trait vertical

posé au-devant de l'indice de la dérivation) peut être effectuée, ce qui fera correspondre à chaque réseau des tenseurs *: le «tchebychevien»

$$\tau_i \equiv \frac{1}{2}\Phi^\alpha_\beta \Phi^\beta_{i|\alpha}$$

($\tau_i = 0$ est la caractéristique du réseau de Tchebychev) et le «géodésique»

$$\gamma^i_{jk} \equiv \frac{1}{2}\left[\Phi^i_{j|k} + \tau_\omega(\delta^i_k \Phi^\omega_j - \delta^\omega_j \Phi^i_k)\right] = \gamma^i_{kj}$$

($\gamma^i_{jk} = 0$ est la caractéristique du réseau géodésique). Notons une propriété du tenseur géodésique: si deux réseaux $\underset{1}{\Phi}$ et $\underset{2}{\Phi}$ sont séparés ($h \neq \pm 1$) et le tenseur géodésique du premier réseau est apolaire au tenseur principal du second ($\underset{1}{\gamma}{}^\alpha_{j\beta}\underset{2}{\Phi}{}^\beta_\alpha = 0$), le premier réseau est nécessairement géodésique ($\underset{1}{\gamma}{}^i_{jk} = 0$).

En marquant toujours les tenseurs appartenant à l'un ou à l'autre réseau par les chiffres 1, 2, nous aurons:

$$\frac{\partial}{\partial u^i}\underset{12}{h} = \underset{1}{\gamma}{}^\alpha_{i\beta}\underset{2}{\Phi}{}^\beta_\alpha + \underset{2}{\gamma}{}^\alpha_{i\beta}\underset{1}{\Phi}{}^\beta_\alpha + (\underset{1}{\tau}_\omega - \underset{2}{\tau}_\omega)(\underset{1}{\Phi}{}^\alpha_i \underset{2}{\Phi}{}^\omega_\alpha - \underset{12}{h}\delta^\omega_i)$$

[la disparité apparente des indices 1 et 2 s'explique bien par la relation (2)]. Conclusion: si nous considérons les quatre propriétés suivantes de deux réseaux séparés: 1) le premier réseau est géodésique; 2) le second réseau est géodésique; 3) les tenseurs tchebycheviens des deux réseaux sont identiques; 4) les réseaux sont en rapport anharmonique constant; — trois quelconques de ces propriétés entraînent la quatrième**. En vue du fait que certaines classes remarquables de réseaux sont caractérisées par les proprietés simples de leurs tenseurs tchebycheviens [on trouvera quelques exemples relatifs à la théorie métrique des surfaces dans les Notes (1) et (2)], on peut énoncer quelques théorèmes géométriques, par exemple: sur une quadrique (non developpable) il n'existe pas de réseau géodésique en rapport anharmonique constant avec le réseau des génératrices rectilignes: en particulier, il n'existe pas de réseau de Voss (réseau conjugué et géodésique).

3. Considérons sur une surface trois réseaux $(\underset{1}{\Phi}, \underset{2}{\Phi}, \underset{3}{\Phi})$, dont les deux premiers sont harmoniques au troisième ($\underset{13}{h} = \underset{23}{h} = 0$); on peut établir la relation:

$$(\underset{12}{h} - 1)\underset{3}{\gamma}{}^\alpha_{\lambda\beta}(\underset{1}{\Phi}{}^\beta_\alpha + \underset{2}{\Phi}{}^\beta_\alpha)(\underset{1}{\Phi}{}^\lambda_i + \underset{2}{\Phi}{}^\lambda_i) = 2\sqrt{\underset{12}{h^2} - 1}\,(\underset{2}{\tau}_i - \underset{1}{\tau}_i) + \underset{3}{\Phi}{}^\alpha_i \frac{\partial}{\partial u^\alpha}\underset{12}{h}, \quad (3)$$

---

* On trouve ces tenseurs dans les Notes (1) et (2), l'expression y est quelque peu différente.

** En ajoutant cette proposition au théorème de la Note (2) concernant les réseaux géodésiques «singuliers», on arrive à une conclusion d'un caractère purement projectif. Soient données dans un plan quatre familles de droites, chacune à un paramètre, et telles que par chaque point (d'une partie suffisamment petite) du plan, il passe une droite de chaque famille. Le rapport anharmonique de quatre droites passant par le même point sera constant dans le cas et dans ce cas seulement, où les dites familles présentent quatre faisceaux, dont les centres sont situés sur la même droite.

où l'on doit mettre le signe de la racine carrée en rapport avec ceux des tenseurs Φ, de façon qu'on ait

$$2\sqrt{h_{12}^2 - 1} = \Phi_{1}^{\alpha}\Phi_{\alpha}^{\mu}\Phi_{\mu}^{\lambda}\,(= -\Phi_{2}^{\alpha}\Phi_{\alpha}^{\mu}\Phi_{\mu}^{\lambda}).$$

En se fondant sur (3) on peut démontrer le

Théorème. *Si nous considérons les trois propriétés suivantes de deux réseaux séparés* (Φ_1 *et* Φ_2) *dont le chacun est harmonique à un troisième réseau* (Φ_3):

1) *les tenseurs tchebycheviens des deux premiers réseaux sont égaux* ($\tau_1 = \tau_2$);

2) *ces réseaux sont en rapport anharmonique constant* ($h_{12} = \text{const} \neq \pm 1$);

3) *le troisième réseau est géodésique* ($\gamma_3 = 0$),

— *deux quelconques de ces propriétés entrainent la troisième.*

Notons une conséquence de ce théorème: si le réseau «caractéristique»* d'une surface est formé de géodésiques, les lignes de courbure sont des asymptotiques virtuelles et, par conséquent, la surface est une déformation d'une surface minimum.

4. En généralisant la notion du «faisceau de réseaux» due à E. Wilczinsky (4), nous allons appeler «réseau à base B» l'ensemble de ∞^1 réseaux (C) tels que: 1) chaque réseau C est harmonique au réseau B, 2) deux réseaux C sont toujours en rapport anharmonique constant. Un tel faisceau est bien déterminé dès qu'on connaît sa base B et un de ses réseaux C_0. Le théorème précédent a pour conséquences: 1) *tous les réseaux harmoniques à un réseau géodésique donné et dont les tenseurs de Tchebychev sont égaux forment un faisceau;* 2) *dans un faisceau à base géodésique tous les réseaux ont un même tenseur de Tchebychev;* 3) *si deux réseaux appartenant à un faisceau ont un même tenseur de Tchebychev, la base de ce faisceau est géodésique* (et, par conséquent, tous les réseaux du faisceau auront le même tenseur de Tchebychev). Voici quelques applications:

1°. Étant donné sur une surface à $ds^2 = g_{\alpha\beta}du^\alpha du^\beta$ un réseau orthogonal

$$\varphi_{\alpha\beta}du^\alpha du^\beta = 0 \tag{4}$$

($g^{\alpha\beta}\varphi_{\alpha\beta} = 0$), on obtient tous les réseaux orthogonaux, ayant le même tenseur de Tchebychev que le (4), en construisant le faisceau suivant (dont la base est le réseau isotrope)

$$(\varphi_{\alpha\beta}\cos 2\eta + \varepsilon^{\mu\nu}g_{\alpha\mu}\varphi_{\beta\nu}\sin 2\eta)\,du^\alpha du^\beta = 0, \tag{5}$$

où $\varepsilon^{11} = \varepsilon^{22} = 0$, $\varepsilon^{12} = -\varepsilon^{21} = (\text{Det}\ g_{ij})^{-\frac{1}{2}}$; la paramètre η signifie l'angle de la rotation qui fait coïncider les directions des courbes (4) avec celles des courbes (5).

2°. Soit donné sur une surface déterminée par ses tenseurs gaussiens g_{ij}, b_{ij} un réseau de Voss

$$V_{\alpha\beta}du^\alpha du^\beta = 0. \tag{6}$$

Le faisceau qui a (6) pour base et qui contient le réseau asymptotique $b_{\alpha\beta}du^\alpha du^\beta = 0$ sera formé de réseaux virtuellement-asymptotiques. On peut

* Adaptant la plus usuelle terminologie nous appelons ainsi le réseau conjugué harmonique au réseau des lignes de courbure [«réseau L» de la Note (3)].

en déduire non seulement le fait établi par Bianchi, que la surface de Voss peut être déformée au réseau (6) persistant, mais aussi la possibilité de trouver sans quadratures le deuxième tenseur gaussien $b_{ij}^{(h)}$ de la surface $S^{(h)}$ qui correspond à la valeur h du paramètre de la déformation:

$$b_{ij}^{(h)} = h b_{ij} + \sqrt{1-h^2}\sqrt{g:V}\ \varepsilon^{\mu\nu} V_{i\mu} b_{j\nu} \qquad (7)$$

($g = \mathrm{Det}\, g_{ij}$; $V = \mathrm{Det}\, V_{ij}$). En particulier, pour $V_{ij} \equiv g_{ij}$ (surface minimum) la formule (7) donne le deuxième tenseur gaussien de la surface associée à la surface minimum donnée.

3°. Pour une quadrique, la connaissance d'un réseau conjugué à invariants de Laplace-Darboux égaux (tel est, par exemple, le réseau des lignes de courbure) permet de construire ∞^1 réseaux du même genre, à savoir—le faisceau qui contient le réseau donné et qui a pour base le réseau asymptotique (dans l'exemple susdit ce faisceau contient aussi le réseau caractéristique).

Institut Mathématique
de l'Université de
Moscou.

Manuscrit reçu
le 15. VI. 1936.

LITTÉRATURE CITÉE

[1] J. Doubnoff, C. R., **192**, 261—264 et 1604 (1931). [2] J. Doubnoff, C. R. Acad. Sci. URSS, IV (XI), № 1—2, 7—11 (1935). [3] N. Efimov, Ibid., 3—6. [4] E. Wilczinsky, Amer. Journ. of Math., **42**, 211—221 (1920).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

PHYSIQUE

CHANGEMENT DE LA BRILLANCE DU FAISCEAU DE RAYONS PENDANT LA RÉFRACTION

Par M. M. GUREVIČ

(Présenté par S. I. Wawilow, de l'Académie, le 4. IX. 1936)

Il est établi depuis longtemps dans la théorie d'irradiation que le passage du rayon d'un milieu à l'indice de réfraction n_1 dans l'autre à l'indice n_2 est accompagné d'un bond de la brillance.

Soit B la brillance d'un rayon incident sur la surface de séparation de deux milieux. Alors la brillance B' du rayon réfléchi sera $B' = \rho B$, où ρ est le facteur de réflexion de la surface de séparation, et la brillance B'' du rayon réfracté sera exprimée ainsi: $B'' = B(1-\rho)\left(\frac{n_2}{n_1}\right)^2$, où $(1-\rho)$ est le facteur de transmission de la surface de séparation dépendant de l'angle d'incidence du rayon, et $\left(\frac{n_2}{n_1}\right)^2$—le facteur constant dépendant des changements dans la structure géométrique du rayon après la réfraction.

Dans les cas fréquents du passage des rayons de l'air ($n_1 = 1$) dans le verre ($n_2 = 1.52$) ce facteur constant possède la valeur 2.3 et le multiplicateur $(1-\rho)$ pour les angles d'incidence pas trop grands ne différant que peu de l'unité, la brillance dans l'air et celle dans le verre diffèrent plus que de deux fois. Cette valeur serait bien facile à mesurer expérimentalement si ce n'était le bond inverse de la brillance ayant lieu sur l'autre surface, par laquelle le rayon sort du verre en l'air. Cette dernière circonstance ne permet pas de vérifier par la voie photométrique la loi déduite théoriquement.

Pourtant s'il est impossible de faire la vérification en mesurant la brillance, la théorie peut bien être vérifiée en mesurant le flux lumineux. Le flux lumineux F tombant sur une petite surface σ dans des conditions de lumière diffuse à la brillance B s'exprime par $F = \pi\sigma B$. Si nous réussissions à augmenter le flux lumineux sans changer le caractère d'éclairage, la brillance serait augmentée.

L'expérience a été effectuée de la manière suivante. Une petite ouverture dans la paroi d'une sphère de diamètre de 40 cm blanchie dedans servait comme source de la lumière diffuse (fig. 1). On plaça la lampe L dans un cylindre métallique derrière un verre blaça mat M monté dans la paroi de la sphère. Cette lampe envoyait sa lumière dans la sphère inférieure, dont les parois blanches éclaraient d'une lumière diffuse l'ouverture supérieure. Contre l'ouverture de la sphère inférieure on pouvait ajuster en haut une autre sphère à l'intérieur blanc qui servait à mesurer le flux lumineux passé par l'ouverture. La mesure fut effectuée au moyen d'un pho-

tomètre de laboratoire, dirigé à travers l'ouverture D sur la paroi de la sphère supérieure.

Ayant fait un trou rond de 10 mm de diamètre dans une mince plaque métallique, on plaça la plaque sur l'ouverture entre les deux sphères et mesura ensuite le flux lumineux F_1 qui avait pénetré par cette ouverture dans la shpère supérieure: $F_1 = \pi\sigma B_1$.

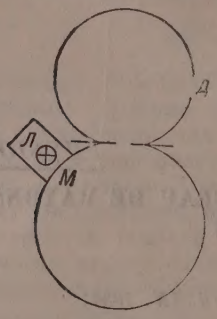


Fig. 1.

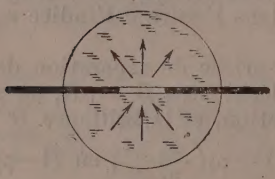


Fig. 2.

Puis on plaça cette plaque ayant la même ouverture entre deux hemisphères en verre (fig. 2), le vide entre les hemisphères ayant été rempli par un liquide transparent à l'indice de réfraction proche à celui du verre. L'ouverture susdite se trouvait ainsi dans les conditions de lumière diffuse mais dans un milieu à l'indice de réfraction 1.52, tandis que le flux lumineux entrait et sortait du verre à la surface dans la direction proche à la normale et pour cette raison ne subissait pas à la surface une réflexion considérable. Le flux lumineux F_2 passé suivant tout ce système dans la sphère supérieure fut enregistré par le photomètre dirigé à travers l'ouverture D. Conformément au premier cas: $F_2 = \pi\sigma B$.

Il fut etabli de plus que $\frac{F_2}{F_1} = \frac{B_2}{B_1} = 2.0$,

c'est-à-dire que le flux lumineux passé par l'ouverture dans la plaque métallique était environ deux fois plus grand dans le second cas que dans le premier, ce qui prouve d'une manière évidente une augmentation réelle de la brillance des rayons deux fois plus grande dans le verre que dans l'air. Si nous avions mesuré la brillance de l'ouverture sans verre et avec le verre au lieu de mesurer le flux lumineux passé par la sphère de verre, nous aurions reçu dans le premier cas la valeur B_1, et dans le second, une valeur quelque peu moindre, décrue à cause des pertes de la lumière dues à la réflexion et l'absorption. L'augmentation du flux lumineux après son passage à travers la sphère de verre est à expliquer par l'impression que l'ouverture σ exerce sur notre œil, qui la voit à travers l'hemisphère supérieure considérablement agrandie. Au cas que la surface plane située au centre de l'hemisphère soit assez petite, l'augmentation de l'aire faira n^2. Mais la dimension de l'ouverture σ restant en réalité la même, tandis que le flux lumineux diffus, passant par l'ouverture, s'augmente, il est évident que la brillance dans le milieu à l'indice de réfraction n accroit n^2 fois.

Le fait que le rapport déterminé des flux n'atteint quelque peu la valeur théorique du rapport des indices de réfraction élevé au carré $\left(\frac{n_2}{n_1}\right)^2 = 2.3$, trouve son explication dans ce qui suit. D'abord, la reflexion de la lumière a lieu sur la surface de chaque hemisphère, ce qui doit diminuer la valeur trouvée en rapport de $(1-\rho)^2 = 0.92$. Puis le verre dont nous nous sommes servi n'est pas d'une transparence idéale et la sphère ayant un diamètre de 40 mm, il en résulte à la suite d'absorption de la lumière par le verre, la nécessité d'introduire un facteur d'ordre 0.96. Le produit de $2.3 \cdot 0.92 \cdot 0.96$ donne le nombre 2.03, bien proche au rapport obtenu.

Institut d'Optique.
Léningrad.

Manuscrit reçu
le 4. IX. 1936.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

PHYSIQUE

SUR LES PARCOURS DES PARTICULES CONSTITUANTES DES "GERBES" DE RAYONS ULTRA-PÉNÉTRANTS

Par N. IVANOVA

(Présenté par A. Joffe, de l'Académie, le 1. VIII 1936)

A côté de la méthode de la chambre de Wilson qui a conduit à la découverte du phénomène des gerbes et qui fournit des données immédiates sur ce phénomène, un rôle des plus essentiels pour l'élucidation du mécanisme et de la nature du phénomène des gerbes revient aux résultats d'une autre méthode, proposée par Rossi, celle de l'observation des coïncidences dans les groupes de compteurs de Geiger-Müller à axes disposés en triangle.

En particulier, une appréciation de l'absorption subie par les particules constituantes des gerbes peut être obtenue en examinant la courbe, dite courbe de Rossi, qui donne le nombre des gerbes exitées par unité de temps dans un certain écran en fonction de l'épaisseur de ce dernier.

On sait que cette courbe est du typeusuel des courbes «de transition» habituelles, donnant l'allure de l'accumulation des rayons secondaires lors de la pénétration du faisceau primaire du vide dans le milieu absorbant et corespond pour l'essentiel à l'équation:

$$N = c\frac{\mu}{\nu - \mu}(e^{-\mu x} - e^{-\nu x}).$$

Les coefficients d'absorptions μ et ν sont déterminés par la forme de la courbe. Toutefois, comme le signalent Geiger et Fünfer ([1]), la courbe de Rossi admet une interprétation ambiguë, pour autant qu'il reste incertain, lequel des deux paramétre en question (ν ou μ), détermine l'absorbabilité des particules constituantes des gerbes et lequel doit être attribué à la composante «gerbigène» (la permutation de ν et de μ ne modifie pas la forme de la courbe).

Partant de certaines considérations d'ordre général, Geiger et Fünfer([1]) arrivent à la conclusion que c'est le moindre des deux coefficients (ν et μ) qui caractérise l'absorbabilité des gerbes mêmes, ou de leurs particules constituantes, ausquelles doit être attribuer un pouvoir de pénétration bien plus grand que ce du rayonnement qui les engendre.

La question de l'absorbabilité ou des parcours des particules constituant les gerbes peut être résolue directement, par exemple, de la façon suivante.

Entre la plaque de plomb (dont l'épaisseur correspond au maximum de la courbe de Rossi) et le groupe des compteurs enregistrant les gerbes qui prennent naissance dans la plaque, sont introduits des lames d'aluminium. Le nombre des gerbes engendrées dans l'aluminium est considérablement moins élevé que pour le plomb. L'allure de la courbe de l'effet (nombre des triples coïncidences par heure) suivant l'épaisseur de l'aluminium est déterminée dans l'essentiel par l'absorption des gerbes formées dans le plomb et

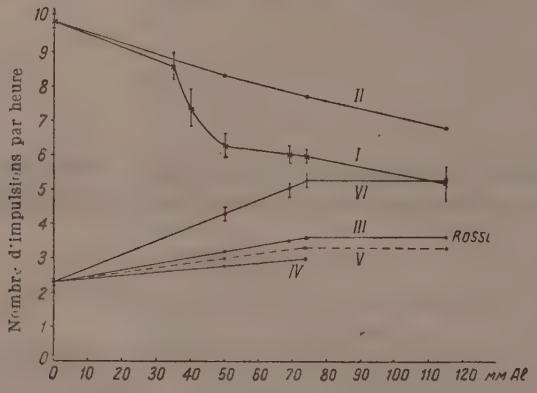


Fig. 1.

traversant l'aluminium. En observant cette courbe on peut obtenir des données immédiates concernant l'absorption que subissent dans l'aluminium les gerbes émises par la plaque de plomb.

La courbe *I* de la fig. 1 représente les résultats d'une série d'observations effectuées dans les conditions sus-indiquées. Les compteurs, comme le montre la fig. 3, étaient couverts d'un écran de 16 mm de Pb$+x$ mm de Al. Les épaisseurs d'aluminium (x) sont marquées sur l'axe des abscisses.

Les ordonnées donnent le nombre de coincidences par heure. La courbe *II* fait voir l'allure à laquelle il fallait s'attendre conformément à l'hypothèse de Geiger-Fünfer (en partant de l'évaluation du coefficient d'absorption des rayons corpusculaires composant les gerbes—des électrons C, selon les notations de Geiger, $\nu_{Pb}=0.5\ cm^{-1}$, ce qui donne

$$\nu_{Al} = \nu_{Pb} \frac{z^2_{Al}}{z^2_{Pb}} \frac{\rho_{Al}}{\rho_{Pb}} \frac{A_{Pb}}{A_{Al}} = 0.046\ cm^{-1}.$$

Ainsi donc les valeurs obtenues sont en très franche contradiction avec la supposition de Geiger-Fünfer.

Contre l'interprétation de ces auteurs témoigne également notre observation que voici: à bonne distance des compteurs était introduit un filtre en plomb de 16 mm d'épaisseur (couche de plomb à 140 cm au-dessus des compteurs, recouvrant une aire de 300 cm $\times$275 cm). Le nombre des gerbes de pareil filtre, enregistrées par les compteurs, est relativemant faible (4.0 ± 0.2 par heure, tandis que le «fond» des coïncidences parasitaires sans filtre, dû aux parois de l'emplacement etc. se monte à 2.3 ± 0.1 par heure). En introduisant immédiatement au dessus des compteurs un écran de plomb d'épaisseur maximum (16 mm), on observait 6.7 ± 0.25 coïncidences par heure, c'est-a-dire, que l'écran, dans ces conditions, faisait augmenter le nombre

des coïncidences de plus de 2.7 par heure. Il faut conclure de là que le nombre des gerbes provoquées dans l'écran par une radiation filtrée à travers 16 mm de Pb dépasse 2.7 par heure (de 2.7 à 4.4 par heure).

Suivant Geiger-Fünfer il faut attribuer à la composante «gerbigène» un coefficient d'absorption égal à 1.2 cm^{-1} Pb. En partant de cette valeur on peut calculer l'affaiblissement de l'effet que doit entraîner une filtration à travers 16 mm de plomb (épaisseur de la couche de plomb immédiatement au-dessus des compteurs). En se basant sur un pareil calcul il eût fallu s'attendre en présence du filtre à 1.1 gerbe par heure de l'écran de plomb

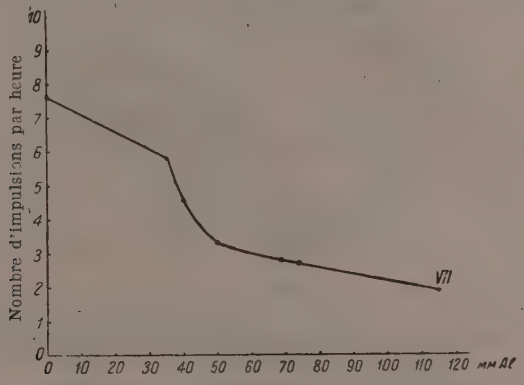


Fig. 2.

couvrant les compteurs, en tant que le même écran sans filtre donne 7.6 coïncidences par heure. En fait, comme il est dit plus haut, le nombre des gerbes dépasse 2.7 par heure.

Pour obtenir la courbe de l'absorption dans l'aluminium des gerbes prenant naissance dans le plomb il faudrait déduire des valeurs de la courbe *I* le nombre des gerbes provenant des couches d'aluminium ayant servi d'absorbant. Ce dernier nombre peut être estimé grosso modo par deux procédés différents. En premier lieu, en tirant parti de la courbe de Rossi ordinaire pour l'aluminium (*VI*), qui a été observée jusqu'à, une épaisseur de 115 mm de Al. On peut tenir compte de l'action de la couche de plomb surmontant l'aluminium dans les observations de la courbe *I* en introduisant le facteur $e^{-0.5\times1.6}$ ([2]). Le résultat est montré dans la courbe *III*. En second lieu, on peut mettre à profit la courbe qui donne le nombre des gerbes observées sous le filtre de plomb dépendant de l'épaisseur de l'aluminium placé immédiatement au-dessus des compteurs. Il est indispensable, en outre, de tenir compte ici de la différance des valeurs du «fond» selon qu'il est observé avec ou sans le filtre (couche) de plomb. En déduisant de cette courbe les coïncidences parasitaires, provoquées par les gerbes dues au filtre, nous obtenons la courbe *IV*.

En adoptant pour représentation des nombres de gerbes provenant de l'aluminium la courbe *V* tracée au pointillé, qui est une certaine moyenne des courbes *IV* et *III* et en en déduisant les ordonées de celles de la courbe *I*, nous pouvons obtenir avec une certaine approximation l'allure de la courbe de l'absorption des gerbes (provenant du plomb) dans l'aluminium— la courbe *VII* (fig. 2).

La distinction faite entre les gerbes provenant du plomb et celles provenant de l'aluminium est, bien entendu, quelque peu arbitraire et une courbe

fondé sur une telle distinction ne saurait fournir qu'une grossière approximation de la courbe de l'absorption des gerbes. Il importe cependant de faire remarquer une singularité que la courbe *I* met en relief indépendammant de savoir si le fond est correctement traité ou non. Il s'agit d'une discontinuité prés de $x=35$ mm de Al dans laquelle se manifeste la présence d'un groupe de particules ayant un parcours déterminé, dépassant 16 mm de plomb.

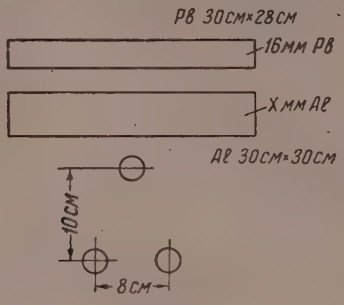


Fig. 3.

D'après la courbe *I* il est possible également qu'il existe parmi les gerbes un autre groupe—à long parcours.

Pareil groupe a été observé par Akkeman et par d'autre auteurs. L'existence de deux groupes de particules secondaires, dont une à 350 mm de parcours dans le fer, est également signalée par Kulenkampf et Maas [3])

En réscumant il est à noter que les résultats exposés ci-dessus étant en contradiction flagrante avec l'hypothese de Geiger-Fünfer ne s'accorde pas bien, d'autre part, avec la conception de Rossi (en tant que selon cet auteur il ne fallait pas s'attendre a un groupe intense de parcours surpassant sensiblement 16 mm de plombe).

Il parait que le schema proposé par Rossi ne suffit pas pour expliquer les phénomènes en question («Übergangseffekte») dont le mécanisme est probablement très complex.

Pour terminer je tiens à exprimer ma profonde gratitude au prof. D. Skobelzyn pour ses précieux conseils et pour la direction générale accordée à mon travail.

Institut Physico-Technique
de Léningrad.

Manuscrit reçu
le 1. VIII 1936.

LITTÈRATURE CITÉE

[1] H. Geiger, E. Fünfer, ZS. f. Phys., **93**, 543 (1934). [2] H. Bethe, W. Heitler, Proc. Roy. Soc., **146**, 83 (1934). [3] H. Kulenkampf, Phys., ZS., **96**, 785 (1935).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

PHYSIK

ÜBER EINE NEUE KONSTRUKTION VON POLARISATIONSPRISMEN

Von W. A. OSIPOV-KING

(Vorgelegt von S. I. Wawilow, Mitglied der Akademie, d. 26. V. 1936)

Beim Arbeiten im Ultraviolett ist im Falle polarisierten Lichts die Transparenz der Kittschicht des Polarisationsprisms wie auch des Prismenmaterials selbst im genannten Spektralbereich eine unerlässliche Bedingung.

Das Prismenmaterial—Doppelspat*—ist für Wellenlängen bis 2300 Å durchsichtig, die Kittschicht dagegen—gewöhnlich Kanadabalsam und Leinöl—undurchsichtig.

Da die ultravioletten Strahlen durch obige Materialien absorbiert werden, so ersetzt man die letzteren gewöhnlich durch eine Luftzwischenschicht oder durch Glyzerin.

Die Luftzwischenschicht setzt die optischen Eigenschaften der Prismen herab, sie erzeugt nämlich eine Einengung des Polarisationsfeldes, und wird daher ein solches Prisma, z. B. das Foucault'sche, nur im Falle paralleler oder unter geringem Winkel konvergierender Strahlen benutzt. Ausserdem steigt bei einer Luftzwischenschicht die im Innern des Prismas reflektierte Lichtmenge.

Prismen mit Glyzerinzwischenschicht bieten zwar ein grösseres Polarisationsfeld, erfordern jedoch eine ganz bestimmte Glyzerinsorte, und ist das Fassen solcher mit entsprechendem Schutz vor Verunreinigung des Glyzerins ausgestatteten Prismen mit grossen Schwierigkeiten verknüpft.

Das nachstehend beschriebene Prisma** weist die obenerwähnten Nachteile nicht auf. Es unterscheidet sich von den existierenden Konstruktionen dadurch, dass statt des bisher gebrauchlichen Verkittens der einzelnen Prismenteile eine Verbindung derselben durch optischen Kontakt mit einer dünnen, planparallelen Zwischenplatte bewerkstelligt wird, welche die ultra violetten Strahlen nicht absorbiert und den erforderlichen Brechungsindex aufweist.

Der optische Kontakt wird durch ein hierfür speziell ausgearbeitetes Verfahren herbeigeführt, das im Vergleich zu den üblichen gewisse Eigenhei-

---

* Aus der Lagerstätte im Jakutgebiet.
** Prisma von Osipov-King, Patent No. 43185 vom 31/V 1935

ten aufweist. Sein hauptsächlichster Vorzug besteht darin, dass der optische Kontakt sich nicht mit der Zeit auflöst, wie dies beim «Cornu»-Prisma, den Michelsonschen Echelons und anderen Details der Fall ist.

Technische Beschreibung des Prismas

Das Prisma stellt ein rechtwinkliges, diagonal in zwei Hälften geteiltes Parallelepipedon aus Doppelspat dar (Fig. 1).

Die optische Prismenachse liegt in der Ebene *A* und kann parallel der Prismenkante *BC* oder unter einem Winkel von 45° zu ihr gerichtet sein.

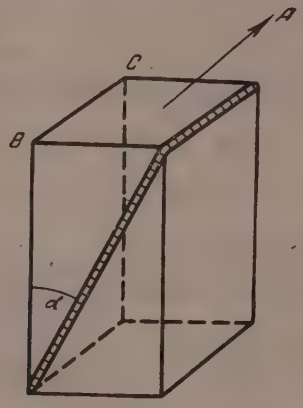


Fig. 1.

Der Winkel α der Prismenhälften kann beliebig ausfallen, je nach den Anforderungen, denen die Weite des symmetrischen Polarisationsfeldes zu genügen hat.

In der Abbildung ist die Zwischenplatte, mit welcher beide Prismenhälften durch optischen Kontakt* verbunden sind, schraffiert dargestellt.

Bei einem Winkel $\alpha = 23°$ und bei Anwendung einer Zwischenplatte aus geschmolzenem Quarz, besitzt, das Prisma ein volles Polarisationsfeld von 26° 30′ und ein symmetrisches von 18°30′.

Bei Prismen, die vor einem Jahr im Optischen Institut der UdSSR geprüft wurden, erwies sich der optische Kontakt nach Jahresfrist als völlig unverändert.

Bei Wärmestossprüfungen hielten die Prismen schroffem Temperaturwechsel von 70° stand und wiesen keinerlei Beschädigungen auf. Beim Prüfen eines Prismas mit Zwischenplatte aus geschmolzenem Quarz erwies sich dasselbe im Ultraviolett für Wellenlängen bis 2300 Å durchlässig (Fig. 2). Das Obere Spektrum gehört Strahlen, die das Prisma passierten, das untere ist ohne Zwischenschaltung eines solchen aufgenommen.

Das beigefügte Spektrogramm ist von E. N. Brumberg im Laboratorium des Mitglieds der Akademie d. Wissenschaften Wawilow am Optischen Institut aufgenommen worden.

---

* Nach diesem Prinzip lassen sich auch doppelbrechende im Ultraviolett durchsichtige Prismen konstruieren, z. B. Wollaston, Rochon, Senarmont.

Das Prisma wurde in einen Leitz'schen Quarzspektrographen einmontiert. Als Lichtquelle diente eine Quarzquecksilberlampe, die ein Spektrum bis 2300 Å liefert.

Diese neue Konstruktion weist das denkbar grösste Auflösungsvermö-

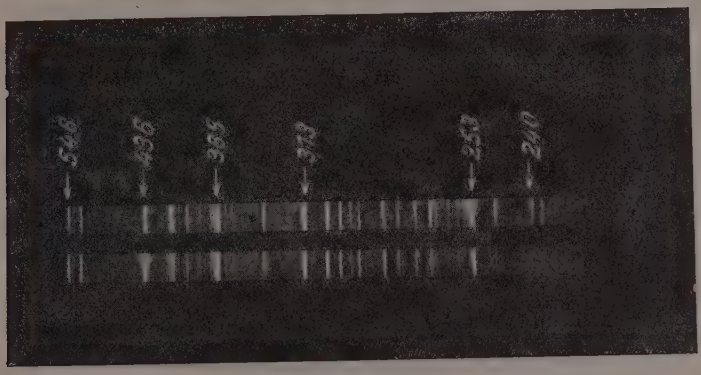


Fig. 2.

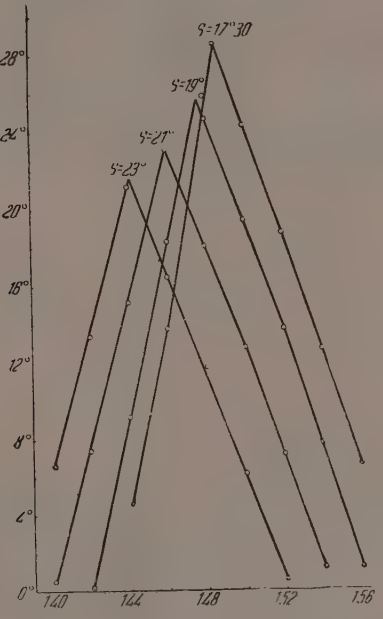


Fig. 3.

gen auf, da ja bei der Herstellung der erwünschte Grad von Genauigkeit in Winkeln und Flächen den nämlichen Präzisionsgrad des Gesamtprismas gewährleistet, was bei der gekitteten Prismen, infolge der häufig beobachteten Keilförmigkeit der Kittschicht, nicht immer erstrebt werden kann;

hierzu gesellt sich die Inhomogenität dieser Schicht, sowie auch der Umstand, dass sie im Laufe der Zeit Veränderungen unterliegt.

Eine Hauptbedingung ist, dass die optischen Achsen beider Prismenhälften einander parallel verlaufen. Ist dieses nicht der Fall, so mischt sich unpolarisiertes Licht bei, wie dies häufig bei der Anfertigung Arens'scher, aus drei Teilen zusammengesetzter Prismen vorzukommen pflegt.

Soll das Prisma für Arbeiten im sichtbaren Spektralbereich benutzt werden, so kann die Quarzzwischenschicht durch optisches Glas von entsprechendem Brechungsindex ersetzt werden. Derartige Glassorten liefern die russischen optischen Glashütten zur Zeit noch nicht: solche können von Schott bezogen werden, z. B. $n_D = 1.4606$; $\nu = 67.2$.

Dank seinem hohen Auflösungsvermögen kann das hier beschriebene Prisma beim Konstruieren sämtlicher Instrumente Verwendung finden, wo Polarisationsprismen gesteigerten optischen Anforderungen genügen müssen, z. B. für Analysatoren in Polarisationsmikroskopen.

Nachstehend ist graphisch die Abhängigkeit der Weite des symmetrischen Polarisationsfeldes des Prismas vom Brechungsindex der Zwischenschicht und vom Winkel der Prismenhälften dargestellt (Fig. 3).

Auf der Abszissenachse sind die Brechungsindizes der Zwischenschicht, auf der Ordinatenachse die Weite des symmetrischen Polarisationsfeldes aufgetragen.

Die jedem Schaubild beigefügten Zahlen entsprechen dem Winkel α der Prismenhälften.

Es sei zum Schluss noch hervorgehoben, dass das Anfertigen solcher Prismen aus verschiedenen ultraviolettdurchlässigen Materialien, wie geschmolzener Quarz, Fluorit u. a., den Bau neuer Polarisationsapparate ermöglicht, die bisher aus Mangel an Polarisationsprismen geeigneter Konstruktion noch nicht zur Ausführung gelangen, wie z. B. Polarisationsmikroskope für ultraviolette Strahlen.

Optisches Institut.
Leningrad.

Eingegangen
d. 26. V. 1936.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

PHYSIK

ÜBER DEN PHOTOGRAPHISCHEN ELEMENTARPROZESS IN IONENKRISTALLEN

Von L. M. SCHAMOVSKIJ

(Vorgelegt von E. V. Britzke, Mitglied der Akademie, d. 22. VIII 1936)

Im Jahre 1896 entdeckte E. Goldstein die Verfärbung der Alkalihalogenide unter dem Einfluss des ultravioletten Lichtes. Später wurden die damit verbundenen Fragen von den Physikern (1) der Göttingen Schule studiert, vor allem von Pohl und Hilsch, welche die grundlegenden Arbeiten in dieser Richtung ausführten und die Natur der latenten photographischen Abbildung endgültig aufklärten.

Dabei wurde festgestellt, dass das Absorptionsspektrum der Mehrzahl der Alkalihalogenide aus scharfen Maxima besteht. Das erste Maximum (mit der grössten Wellenlänge) fällt mit dem Auftreten von Metall- und Halogenatomen im Kristall zusammen.

Wolf und Herzfeld (2) schlugen auf Grund ihrer Vorstellung vom Mechanismus des Prozesses, der bei der Absorption der Lichtenergie in Kristallen vor sich geht, folgende energetische Gleichung, bezogen auf ein Mol, vor: $h\nu = [\text{Elektronenaffinität } (E)] + \left[[\text{Entfernung des Elektrons } \left(A\frac{e^2}{d}\right)]\right] + + \left[\text{Zurückbringen des Elektrons an den Platz des Kations } \left(A\frac{e^2}{d} - \frac{e^2}{d}\right)\right] - [\text{Jonisationsarbeit des Metalles } (I)]$ oder

$$h\nu = E - I + 2(A-1)\frac{e^2}{d}, \qquad (1)$$

A—Madelungsche Konstante, e—Elementarladung, d—Entfernung der Zentren entgegengesetzt geladener Ionen im Kristall.

Die Messungen der Absorptionspektren der Alkalihalogenide [Hilsch und Pohl (3)] zeigten jedoch, dass die Berechnungen nach Gleichung (1) mit den experimentellen Daten um ungefähr 30% auseinandergehen. Sie fanden dass die empirische Gleichung:

$$h\nu = E - I + A\frac{e^2}{d} \qquad (2)$$

mit den Versuchsresultaten besser übereinstimmte.

De-Boer (4) nahm an, dass der Koeffizient $(2A-1)$ richtiger sei und führte deshalb in die Gleichung (1) auf Grund der Arbeiten Borns und Klemms Zusatzglieder ein, die der Polarisation der Ionen und den Absorptionsener-

gien der Metall- und Halogenidatome im Kristallgitter Rechnung tragen sollten. Er kam auf diese Weise zur Gleichung (3):

$$h\nu = E - I + (2A - 1)\frac{e^2}{d} - \Psi_{\text{pol}} - \Omega_{\text{hal}} - \Omega_{\text{alk}}, \qquad (3)$$

die befriedigend mit den experimentellen Daten für Alkalihalogenide übereinstimmt (Tabelle).

Es scheint uns möglich, eine andere energetische Gleichung für das erste Absorptionsmaximum abzuleiten.

Es ist bekannt, dass das Bestehen von entgegengesetzt geladenen Ionen im allgemeinen keinen stabilen Zustand darstellt, da die Bildung von Atomen aus diesen Ionen zu einem System mit einer kleineren potentiellen Energie führt, z. B.:

$$(Na^+) + (Cl^-) = (Na) + (Cl) + 49.3\,\text{kg cal}.$$

Im Kristallgitter jedoch bilden die Ionen untereinander eine bestimmte symmetrische Konfiguration und sind stabil. Das erklärt sich damit, dass in Kristallen unter gewöhnlichen Bedingungen zwei entgegengesetzte Tendenzen wirksam sind: einerseits streben die Ionen in ein System aus Atomen überzugehen anderseits widersetzt sich diesem Bestreben die ihm bei Weitem überlegene elektrostatische Energie der zwischen entgegengesetz geladenen Ionen bestehenden Anziehung (bestimmt durch die Arbeit, die notwendig ist, um die Ionen unendlich weit voneinander zu entfernen).

Aus der Ungleichheit dieser Energien erklärt sich die Stabilität des Kristallgitters:

$$U > I - E. \qquad (4^*)$$

Diese Ungleichung folgt auch aus der Betrachtung des Kreisprozesses von Born und Haber, da in der Gleichung

$$U = Q + S_{\text{Me}} + \frac{1}{2}D_{x_2} + I - E$$

die Summe der ersten drei Glieder stets positiv bleibt.

Wenn die Ionen im Gitter Lichtquanten absorbieren, so wird die Ungleichung (4), d. h. die Stabilität des Ionenkristalles erst dann gestört, wenn

$$U = I - E + h\nu, \qquad (5)$$

d. h. erst von einer bestimmten Frequenz an können sich Atome im Gitter bilden.

Diese Energie wird von den Kristallen absorbiert und drückt sich im Absorptionsspektrum durch ein scharfes Maximum aus.

Daraus folgt, dass das physikalische Bild des elementaren photographischen Prozesses bloss durch einen Akt ausgedrückt wird, nämlich durch den Übergang des Elektrons vom negativen Ion zum positiven, was in Übereinstimmung mit Einsteinschen Annahme einer Absorption von Energiequanten steht.

Wenn man in Gleichung (5) U durch $A\frac{e^2}{d}\left(\frac{n-1}{n}\right)$ ersetzt, so erhält man:

$$h\nu = E - I + A\frac{e^2}{d}\,\frac{n-1}{n}. \qquad (6^{**})$$

---

* Die Differenz $(I - E)$ kann für manche Salze kleiner als Null werden (z. B. CsF), jedoch beibt die Ungleichung (4) immer richtig.

** Bei den Rechnungen ist es besser, sich der experimentell bestimmten Gitterenergien zu bedienen, wie sie aus dem Kreisprozess von Born und Haber folgen. Dabei entfällt die Notwendigkeit die Korrektur für die Polarisation der Ionen im Kristall einzuführen.

Eine nähere Betrachtung dieser Gleichung zeigt, dass sie dann zutrifft, wenn die sich bildenden Atome gasförmige Eigenschaften zeigen.

Wenn man jedoch von den effektiven Radien der Ionen und Atome nach Goldschmidt ausgeht, so kommt man zu dem Schluss, dass die in den Kristallen entstehenden Metallatome ihre effektiven Dimensionen vergrössern, sich infolge der Deformation im Gitter polarisieren, und dass deswegen ihr Vorrat an Energie im Vergleich zu den Atomen im gasförmigen Zustand erhöht wird.

Welche Bedeutung diese Tatsache hat, kann man aus dem Vergleich der auf experimentellem Wege erhaltenen Absorptionsmaxima mit den Resultaten der Rechnungen nach Gleichung (6) ersehen (Tabelle).

Dabei muss man in Betracht ziehen, dass die Genauigkeit, mit der U und E bekannt sind, kaum 5% übersteigt.

Tabelle

Das erste Absorptionsmaximum der Alkalihalogenide in Elektronen-Volt

Salz	$h\nu$ exp.	$h\nu$ berechnet		
		aus Gleichung (2)	aus Gleichung (3)	aus Gleichung (6)[5]
LiCl	—	—	—	7.05
NaCl	—	—	7.6	6.89
KCl	7.60	7.43	7.8	6.93
RbCl	7.40	7.30	7.6	6.88
CsCl	7.57	6.93	—	6.80
LiBr	6.67	7.22	6.5	6.35
NaBr	6.50	6.78	6.7	6.02
KBr	6.58	6.75	6.9	6.15
RbBr	6.43	6.63	6.7	6.04
CsBr	6.49	6.62	—	6.02
LiJ	5.59	5.94	5.1	5.42
NaJ	5.39	5.69	5.5	5.24
KJ	5.63	5.81	5.8	5.46
RbJ	5.55	5.76	5.7	5.37
CsJ	5.63	5.60	—	5.38

Es ist durchaus wahrscheinlich, dass man eine Verkleinerung der Polarisationseffekte, die mit der Bildung von Metallatomen in Gitter verbunden sind, durch Einführung von Ionen mit grossem effektiven Radius erreichen kann.

Es zeigt sich dabei, dass es möglich ist, wenn auch nur qualitativ, die Verschiebung der Lage des Absorptionsmaximums bei der Erforschung der energetischen Stufen in Gemischen von Kristallen, zu erklären. Hilsch und Pohl [3] haben das Absorptionsspektrum der Na-, K- und Rb- Chloride unter Zugabe bis zu 1% der Jodide derselben Metalle gemessen und fanden die Lage der ersten Maxima entsprechend bei 185, 189.5 und 196.5 mμ. Zur Erklärung dieser Tatsache nahmen sie an, dass am elementaren photographischen Prozess J-Ionen teilnehmen, während der Coulomb'sche Anteil der Gitterenergie den Chloriden zugesprochen wurde. Dabei erhielten sie nach Gleichung (2) für diese Salze entsprechend 181; 184 und 188 mμ.

Die Lösung dieser Aufgabe führt uns, ausgehend von Gleichung (6), zu den Grössen 187.5; 189.5 und 193.5 mμ. Dabei gehen wir davon aus, dass

das erhaltene Spektrum ausschliesslich mit den Chloriden verbunden ist*. Die Jodide bilden dabei nur ein Auflockerungsmittel.

Um die Allgemeingültigkeit der abgeleiteten Gleichung zu zeigen, wäre es wünschenswert, festzustellen, wie weit sich obige Gleichung auch für andere Salze bewährt. Ebenso könnten wir gleichzeitig feststellen, ob die empirische Gleichung (2) auch für andere Salze ausser den Alkalihalogeniden, für welche sie abgeleitet wurde, gilt.

Am bequemsten in dieser Beziehung wären die Alkalihydride, da die Rechnung nach Gleichung (6) zeigt, dass das erste Absorptionsmaximum in einem für die Messung bequem erreichbaren Teil des ultravioletten Spektrums liegt**.

In dieser Beziehung ist von grossem Interesse die Arbeit Bach's und Bonhoeffer's (7), die das Absorptionsspektrum des Lithium-hydrids mit einer von ihnen konstruierten Apparatur gemessen haben,. Schon diese Autoren zeigten, dass das von ihnen gefundene erste Absorptionsmaximum 251.7± ±0.2 mμ schlecht mit der Rechnung aus Gleichung (2) übereinstimmt und qualitativ fast nach Gleichung (6) berechnet werden kann. Sie erklärten jedoch nicht die Gründe der Nichtübereinstimmung ihrer Resultate mit Gleichung (2); sie legten bloss ihre experimentellen Werte in der empirisch gefundenen Gleichung (6) nieder. Die Rechnung nach Gleichung (6) gibt für das erste Absorptionsmaximum 257.7—255.3 mμ, während die Gleichung 2 ($n=9$) 207.1—205.4 mμ ergibt.

Um die Richtigkeit der oben abgeleiteten Gleichung zu beweisen, kann man die Nachprüfung auch auf das Gebiet der Photodissoziation von Dämpfen heterogener Moleküle ausdehnen.

Aus dem Kreiprozess Born's und Haber's folgt, dass

$$E - I + U = Q + S_{\mathrm{Me}} + \frac{1}{2} D_{x_2}, \tag{7}$$

wobei Q Reaktionswärme $[\mathrm{Me}] + \frac{1}{2}(x_2) = [\mathrm{Me}x]$ und S_{Me} — Verdampfungswärme des Metalls Me, D_{x_2} — Dissoziationswärme x_2 bedeuten.

Aus den Gleichungen (6) und (7) findet man:

$$h\nu = Q + S_{\mathrm{Me}} + \frac{1}{2} D_{x_2}. \tag{8}$$

Wenn die von uns abgeleitete Gleichung richtig ist, dann muss beim Übergang von Kristallen zur Erforschung der Absorptionsspektra heteropolarer Salze im Dampfzustand für den Anfang der Absorption folgende Gleichung gelten:

$$h\nu = Q + S_{\mathrm{Me}} + \frac{1}{2} D_{x_2} - S_{\mathrm{Me}x}. \tag{9}$$

Ersetzt man die Sublimationswärme $S_{\mathrm{Me}x}$ des Salzes durch $(A-1)\frac{e^2}{d}\frac{n-1}{n}$ und bedient man sich der Gleichung (7), so erhält man:

$$h\nu_1 = E - I + \frac{e^2}{d}\frac{n-1}{n}. \tag{10}$$

In diesem Fall führt die Dissoziation zur Bildung von unangeregten Atomen im gasförmigen Zustand, und es entfällt deswegen die Korrektur für die Deformierung.

---

* Bei der Berechnung wurde U für die Chloride und E für Chlor genommen.

** Die Werte für U und E wurden der Arbeit von J. Kasarnowsky entnommen (6).

Deshalb wäre der experimentelle Beweis der Gleichung (9) wesentlich für die Richtigkeit der Gleichung (6).

Desai (8) führte eine ganze Reihe von Versuchen mit Dämpfen von Alkalifluoriden aus und fand, dass $D_{F_2} = 76 \pm 2$ kg-cal. Davon ausgehend, mass er das Absorptionsspektrum des LiF und setzte für D_{F_2} den Wert aus den vorhergehenden Versuchen ein und fand so aus Gleichung (9) die latente Verdamfungswärme des LiF zu 29.6 ± 0.6 kg-cal, während aus der Dampfdruckkurve 29.57 kg-cal folgt.

Das erhärtet noch einmal die Richtigkeit der abgeleiteten Gleichung (6), um so mehr, als man, ausgehend von den Gleichungen (1), (2) und (3), nicht erklären kann, warum Gleichung (9) stimmt.

Zum Schlusse möchte ich noch Prof. Kapustinsky für seine zahlreichen wertvollen Hinweise und Ratschläge danken.

Institut für angewandte Mineralogie.
Moskau.

Eingegangen
d. 22. VIII. 1936.

ZITIERTE LITERATUR

[1] Ein eingehendes Literaturverzeichniss ist in einer der letzten Arbeiten von R. Hilsch angeführt: Angew. Chem., **49**, 69—73 (1936). [2] Wolf u. Herzfeld, Handbuch d. Physik **20**, 632 (1928). [3] R. Hilsch u. R. W. Pohl, ZS. f. Physik, **57**, 145; **59**, 812 (1929). [4] De-Boer, Electron Emission and Adsorption Phenomena [5] Die Werte für die Berechnung sind entnommen bei J. E. Mayer u. L. Helmholz, ZS. f. Physik, **75**, 19 (1932). [6] J. Kasarnowsky, ibid, **61**, 237 (1930). [7] F. Bach u. K. F. Bonhoeffer, Naturwiss., **20**, 940 (1932) und ZS. f. Physikal. Chem., **23**, 256 (1933). [8] M. S. Desai **128**, 34 (1931); Bull. Acad. Sci. Agr. Oudh. **1**, 116 (1931—32), **2**, 33 (1932); Proc. Roy. Soc (A) **136**, 76 (1932); ZS. f. Physik, **85**, 360 (1933).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

CHEMISTRY

ON THE QUESTION OF PERIODICAL REACTIONS

By F. M. ŠEMJAKIN

(Communicated by N. S. Kurnakov, Member of the Academy, 3. VI. 1936)

A note by Dr. E. C. Baughan (1) was recently published in «Nature» describing some experiments which confirm the results already obtained by us (2) and containing references to the work of Prof. J. A. Christiansen and J. Wulff (3). In this connection I beg to make the following statement. In our works on periodical reactions (2), we were able to give the quantitative charakteristic of those—the constant of periodicity. By the investigation of periodical reactions by the method of Gibb's triangle, it was discovered that the constant, which preserves its constancy in the conditions of the experiment, varies with changes in the concentration of the exterior and the interior components and of the medium.

Table 1

$AgNO_3 + K_2Cr_2O_7$ in Gelatine

Gelatine concentration in %	1	2	3	4	5	10	R. Ed. Liesegang's method
$\lambda\varrho \cdot 10^6$	11	4	3	2	1	1	

$Pb(NO_3)_2 + KI$ in Water

Concentration of KI in Mol	1.0	0.5	0.1	0.05	K. W. Morse 's method
$\lambda\varrho \cdot 10^6$	2.6	3.5	10.0	12.0	

With the decrease in concentration, the «constant» grows, approaching the value of $\lambda\varrho = \frac{hN}{M}$, where λ is the distance between layers, ϱ is the velocity of the expansion of the field of diffusion, h is Planck's constant, N is the Avogadro number, M is molecular weight of the exterior electrolyte. At greater concentrations the value of the constant remains all the time smaller than the theoretical value (Table 1). The values of the boundary constants are given in Table 2.

Table 2

Formula	Molecul. weight	Theoret. $\frac{\lambda\varrho}{4} \cdot 10^6$	Optimal constants of periodicity $\times 10^6$ (experimental)
$Ag_2Cr_2O_7$	432	2.3	2.2 in gelatine
PbI_2	461	2.2	2—2.5 in agar
AgH_2AsO_4	246	4.1	4.4 in agar
$2\,CaO \cdot P_2O_5 \cdot 5\,H_2O$	344	2.9	2.2 in gelatine

Starting from our earlier experimental data J. A. Christiansen and Inger Wulff have given for a number of reactions another formula $\lambda\varrho = \frac{hN}{M_1}$, where M_1 is the molecular weight of the products of the reaction. This formula is applicable to optimal concentrations only.

The maximal values of the constant are three or four times greater, than those calculated by Christiansen. So it is quite apparent to us, that Prof. J. A. Christiansen's interpretation needs an essential modification.

It is possible, that what we are dealing with are waves of reaction and not de Broglie-waves of the molecule. I think of giving my considerations on this question elsewhere in connection with the analogy between molecules and reactions.

Table 3

Reaction	Reaction product and its molec. weight	Theoret. constant of periodicity $\lambda\varrho \cdot 10^6$	Experimental $\lambda\varrho \cdot 10^6$	
			In gel (Liesegang's method)	In water (Morse' s method)
$AgNO_3 + K_2Cr_2O_7$	$Ag_2Cr_2O_7$ 432	9.2	10—12 in gelatine	8
$Pb(NO_3)_2 + KI$	PbI_2 461	8.6	8 in agar	12
$AgNO_3 + NaH_2AsO_4$ . . .	AgH_2AsO_4 249	16.2	13 in agar	—
$Na_2CO_3 + HgCl_2$	$HgCO_3$ 260	15.4	—	18
$Na_2HPO_4 + CaCl_2$	$\left[Ca(HPO_4)_2(H_2O)_4\right]Ca$ 344	11.5	8—11 in gelatine	14

Chemical Institute.
Academy of Sciences of the USSR.
Moscow.

Received
3. VI. 1936.

REFERENCES

[1] E. C. Baughan, Nature, **134**, 778 (1934). [2] P. F. Michaleff, W. K. Nikiforoff u. F. M. Schemjakin, Koll.-Ztschr., **66**, 197 (1934); ЖОХ, **3**, 789 (1933); П. Ф. Михалев и Ф. М. Шемякин, ЖОХ, **3**, 1001 (1933); Ф. М. Шемякин, ЖОХ, **4**, 444—451; **5**, 943—949 (1935); P. F. Michaleff u. F. Schemjakin, Acta phys.-chim. USSR, **2**, 427—432 (1935); ЖОХ, **4**, 1117—1127 (1934); ЖФХ, **5**, 750 (1934): Ф. М. Шемякин, Коллоидн. журн., **1**, 35—37 (1935); Труды Шестого менделеевск. съезда, **1**, 233—234. [3] J. A. Christiansen u. J. Wulff, ZS. phys. Chem., Abt., B., **26**, 187 (1934); also: S. Veil, J. Physique Radium, **5**, 141 (1934); L. May, Koll.-Zschr., **72**, 217—221 (1935); M. Copisarov, Koll.-Ztschr., **54**, 257 (1931). [4] F. M. Schemjakin, Acta phys.-chim. USSR., **2**, 557—558 (1935)

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

CHEMISTRY

ON THE LOWER BOUND OF THE FORMATION OF THE MIXED CRYSTALS OF THE NEW TYPE

By A. POLESICKIJ

(Communicated by W. I. Vernadsky, Member of the Academy, 4.IX.1936)

The formation of mixed crystals of the new type from the components obeying to the Grimm's conditions ([1]) and showing the same stoichiometrical formula, but of the different chemical type, was proved by Grimm and Wagner ([2]) for the case of $BaSO_4$—$KMnO_4$. Later Chlopin and Nikitin showed that such mixed crystals do not form when the concentration of one of the components is very small. In other words there is a lower bound of such a mixing.

This fact is understandable, as the mixed crystals of the new type can be formed only through the substitution of at least one molecule of the first component with a molecule of the second one, but the probability of the collision of both ions of the second component on the surface of the growing crystal at low concentrations is too small.

It is difficult to determine the lower bound of the formation of the mixed crystals of the new type by the increasing of the concentration of the component, that must form the mixed crystals with the crystallizing one, for the solubility of one of the components of the known systems is very small.

In order to determine the lower bound for the system $KClO_4$—$PbSO_4$ the solubility of $PbSO_4$ was increased by the addition of other electrolyte. $KClO_4$ was crystallized from the saturated solution of $PbSO_4$ in concentrated solutions of $NaNO_3$. RaD, the radioactive isotop of Pb, was determined in the solution before and after the crystallization of $KClO_4$, as an indicator of the behaviour of $PbSO_4$.

The results are given in the table.

Table

Concentration of $NaNO_3$ in %	Concentration of $PbSO_4$		Solubility product $[Pb][SO_4'']$	Concentration of $KClO_4$	Crystallized $KClO_4$ in %	Coprecipitated $PbSO_4$ in %
	g/l	mol/l				
0	0.031	0.0001	$1 \cdot 10^{-8}$	—	40	+4
					60	−6
40.6	2.82	0.0092	$8.5 \cdot 10^{-6}$	2.10	70	+8
45.2	3.54	0.0115	$1.3 \cdot 10^{-4}$	2.25	50	−7
					60	−4
46.3	3.62	0.0119	$1.4 \cdot 10^{-4}$	2.38	50	+1
					60	−6

It is seen from the table, that, in spite of a great increase of the solubility product, $PbSO_4$ does not form the mixed crystals with $KClO_4$. It is evidently that either the lower bound is much higher, or the possibility of the formation of the mixed crystals of the new type depends not only on the concetration of the second component, but also on its activity coefficient, which diminishes with the increase of the solubility.

Chemical Laboratory of Radium Institute.
Leningrad.

Received
4. IX. 1936.

REFERENCES

[1] Grimm, ZS. Electrochem, **30**, 467 (1924). [2] Grimm, Wagner, ZS. Phys. Chem., **132**, 131 (1928); Wagner, ZS. Phys (B), **2**, 27 (1929). [3] Chlopin u. Nikitin, ZS. Phys. Chem. (A), **145**, 137 (1929).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

BIOCHEMIE

ÜBER EINE CHEMISCHE METHODE ZUR BESTIMMUNG DES VITAMINS B_1

Von W. A. DEVJATNIN

(Vorgelegt von A. N. Bach, Mitglied der Akademie, d. 28. VIII.1936).

Das Wissenschaftliche Forschungsinstitut der Sowjetunion für die nördliche Kornwirtschaft und Kornbohnenkultur begann schon 1934 mit der Ausarbeitung gewisser Methoden für die chemische Bewertung des Vitamingehalts von Pflanzenprodukten und veröffentlichte 1935 eine Reihe von Arbeiten über die chemische Bestimmung des Vitamins C ([1], [2], [3]).

Unter anderem wurde eine von uns ausgearbeitete chemische Methode zur Bestimmung des Vitamins B_1 ausgeführt.

An der Ausarbeitung dieser Methode waren seit 1934 W. M. Iosikova und seit 1935 E. W. Ziganova beteiligt.

Kinnersley und Peters ([4]) veröffentilchten 1934 eine Methode zur Bestimmung der Aktivität kristallischer Präparate des Vitamins B_1 mit Hilfe der Formaldehyd-Azo-Reaktion.

Die erste Etappe unserer Arbeit bestand in der Prüfung der Spezifität dieser Reaktion. Hierbei überzeugten wir uns davon, dass diese Reaktion nicht nur dem Vitamin B_1 eigen ist, sondern auch mit einer Reihe von Stoffen stattfinden kann, die aktiven Wasserstoff (der Hydroxylgruppe) enthalten. In der Tabelle 1 sind einige unserer Versuchsergebnisse angeführt.

Die von uns erhaltenen Resultate zwangen uns zu der Vermutung, dass bei einer entsprechenden Aussonderung des Vitamins B_1 aus einem Gemisch fremder, die Azo-Reaktion gebender Stoffe, diese Reaktion als ausserordentlich empflindlicher Reagent auf die Bestimmung des Vitamins B_1 mit Erfolg benutzt werden kann.

Nach mühseligem und langem Suchen blieben wir bei folgendem Schema:

1. Aussonderung der Fremdstoffe und des Vitamins B_1 durch Niederschlag. 2. Befreiung des Niederschlags von Kohlehydraten, Alkoholen u. a. durch Auswaschen. 3. Zerlegung des Vitamin B_1 enthaltenden Niederschlags mittels Schwefelwasserstoffs. 4. Reinigung der Vitamin B_1-Lösung von interferierenden Stoffen und Gewinnung einer reinen, Vitamin B_1 enthaltenden Lösung. 5. Untersuchung ihrer Aktivität auf Grund der Formaldehyd-Azo-Reaktion.

Zur Ausfällung der Fremdstoffe und des Vitamins B_1 benutzen wir essigsaures Quecksilber und Platinchlorid.

Da wegen der ausserordentlich geringen Menge an Vitamin B_1 es uns sogar bei den aktivsten Objekten nicht gelang, einen merklichen Niederschlag

Tabelle 1

Prüfung der Spezifität der Formaldehyd-Azo-Reaktion (das +Zeichen deutet auf das Vorhandensein, das —Zeichen auf das Fehlen der Reaktionhin).

Stoff	Reaktion	Stoff	Reaktion
Cystidin	+	Eigelb	+
Glyzerin	+	Bierhefe	+
l-Zystein	+	Eiweiss	−
Azeton	+	Polierter Reis	−
Azetanhydrid	−	Weizenkleie	+
Äthylalkohol	+	Sojabohne	+
Benzol	+	Lathyrus Cicera (grüne Masse)	+
Methylalkohol	+	Maismehl	−
Dimethylglyoxym	+	Knochenmehl	−
d-Arginin	−	Erbsen	+
Tirosin	+	Linsen	+
Xylol	−	Frische Brothefe	+
Essigsäure	−	Autoklavierte Brothefe	−
Azetoessigäther	−	Reiskeime	+
Hydrochinon	−	Trufanovs Präparat B_1	+
Palmitinsäure	−	Bienenhonig	+
Benzaldehyd	−	Kristall. Vitamin B_1 (Jansen)	+
Glykol	−	Kristall. Vitamin B_1 (Peters)	+
Oleinsäure	−	*d*-Glukose	+
Salizylaldehyd	−	*d*-Fruktose	+
Vanillin	−	Saccharose	+
Resorcin	+		

mit Platin zu bekommen, so bedienten wir uns der Adsorptionseigenschaften der Quecksilberazetatniederschläge und fällten den Extrakt mit den angegebenen Reagenten zusammen aus.

Hierbei wurde, erstens, die Trennung der Eiweiss-, Pigment- und Aminosäurefraktion des Extrakts von Kohlehydraten, Alkoholen, Adlehyden usw. erreicht, und, zweitens, wurde von dem Niederschlag der genannten Stoffe das Komplex Platin+Vitamin B_1 vollständig adsorbeirt. Die Wechselwirkungsreaktion des Vitamins B_1 mit dem Lösungsmittel $PtCl_4$ rührt von der Anwesenheit des Stickstoffs des Pyridins und des Schwefels der Thiosolbase des Vitamins her, was klar aus der unten angeführten Formel hervorgeht:

Der Niederschlag der oben genannten Verbindungen absorbiert auch eine gewisse Menge an Kohlehydraten, welche sich durch Auswaschen mit Wasser vollständig daraus entfernen lassen. In allen Fällen wendeten wir die Seliwanowsche Kontrollreaktion auf das Auswaschwasser an.

Den auf diese Weise ausgewaschenen Niederschlag zersetzten wir im Wasser mit Schwefelwasserstoff, wobei zur vollständigen Zerstörung des Komplexes Platin+Vitamin eine zusätzliche Bearbeitung der Suspension mit Ameisensäure beim Siedepunkt des Wassers erfolgte. Die Zersetzung des Niederschlags geht auf diese Weise vollständig und ohne Verlust an Aktivität des Vitamins.

Wir zogen in Betracht, dass bei einer solchen Bearbeitung viele Fremdstoffe, welche vorher mit Quecksilber gebunden waren, wieder in die Lösung übergehen: daher fällten wir sie mit einer Bleiazetatlösung aus, welche nachher auf gewöhnliche Weise in Form von PbS entfernt wurde. Auf diese Weise erhielten wir eine vollkomen farblose und durchsichtige, das Vitamin B_1 enhaltende Flüssigkeit, welche wir weiterhin für die Azo-Reaktion benutzten.

Es wurde festgestellt, dass am charakteristischsten und stabilsten die Färbung der Reaktion bei Erwärmung erhalten wurde, was ermöglicht, sie genau zu kolorimetrieren, ohne sich auf die Zeitgrenze von 15 Min. zu beschränken, wie dies gewöhnlich die Azo-Reaktion bei niedriger Temperatur erforderlich macht. Wir führen hir eine Tabelle an, wo die Eigenschaften der Azo-Reaction bei niedriger und hoher Temperatur verglichen werden.

Tabelle 2

Eigenschaften der Azo-Reaktion bei verschiedenen Temperaturbedingungen

(Objekt—Extrakt aus Bierhefe)

Temperatur d. Lösung	Reaktionsfarbe	Zeit zur Bildung der Maximalintensität der Farbe	Stabilität	Bemerkung
0	Keine Reaktion .	—	—	Wird nach 30 Min. gelb.
25	Rein rosa	30—40 Min	20—30 Min.	
90	Rein rosa	0.5—1 Min	2—3 Std.	Nach 3 Std. die rein rosa Farbe wird schwach, kein Gelb

Mit der von uns verwendeten Methode prüften wir eine Reihe von sowohl das Vitamin B_1 enthaltenden als auch nicht enthaltenden Objekten, worauf wir auf Grund gewisser Daten der unten angeführten Tabelle uns gestatten, die Schlussfolgerung auf ihre Verwendbarkeit in der Laboratoriumspraxis zu ziehen.

Tabelle 3

Prüfung der Spezifizität der Methode an einigen Objekten (die Aktivität der Reaktion mit Bierhefe wird zu 100 angenommen; die Daten gelten für den Rohstoff)

Untersuchter Stoff	Aktivität auf B_1	Zahl d. Bestimmungen	Untersuchter Stoff	Aktivität auf B_1	Zahl d. Bestimmungen
Bierhefe	100	9	Reis+Phenol	0	1
Reiskeime	90—100	2	Reis+Glyzerin . . .	0	1
Reisschalen	80—90	3	Reis+Honig	0	2
Reis in Schalen . . .	70	3	Honig	0	2
Eigelb	50	2	Eiweiss	0	2
Brothefe	20	4	Eiweiss+Zucker . .	0	3
Erbsensamen	10—15	1	Eiweiss+Äthylalkohol	0	1
Polierter Reis	0	2	Eiweiss+Zystein . .	0	1
Reis+Azeton	0	1	Eiweiss+Honig . .	0	1
Reis+Äthylalkohol .	0	1			
Reis+Gystidin . . .	0	1	KünstlicheMischung[6] Eiweiss, Kohlehydrate Aldehyde, Fette, Säuren, Salze, Ketone u. a.	0	1

Weiter unten setzen wir die Technik der Methode auseinander:

1. 10 g des trockenen Stoffes*[1] werden im Mörser zerrieben, in ein Glas geschüttet und mit heissem Wasser (80—90°) übergossen und zwar 200 cm³ Wasser auf die abgewogene Menge. Die Extraktion wird unter häufigem Umrühren eine albe Stunde lang ausgeführt.

2. Nach Abluf der angegebenen Zeit wird der Inhalt des Glases zentrifugiert und 75 cm³ des erhaltenenZent rifugats in eine 100 cm³-Mensur geschüttet, zu dem noch 20 cm³ einer frisch zubereiteten Mischung von 25% Hg $(CH_3COO)_2$+1% $PtCl_4$*[2] hinzugegossen werden. Der Inhalt der Mensur wird darauf sorgfältig geschüttelt und Wasser bis zur Marke hinzugefügt.

3. Das Gemisch wird zentrifugiert, das Zentrifugat aus dem Probiergläschen entfernt und zum Niederschlag Wasser hinzugegossen, der durch sorgfältiges Umrühren mit einem Glasstäbchen ausgewaschen wird. Dann wird nochmals zentrifugiert, das Zentrifugat entfernt und der Niederschlag wieder so mit Wasser ausgewaschen, bis keine Reaktion auf Kohlehydrate in dem Auswaschwasser vorhanden ist. (Für Bierhefe genügt 2—3 maliges Auswaschen oder 100—150 cm³ Wasser.)

4. Der auf diese Weise ausgewaschene Niederschlag wird in einem Erlenmeyerkolben für 250 cm³ unter Zusatz von 95 cm³ Wasser gegeben, wohin noch 5 cm³ 1% Ameisensäure hinzugefügt werden; und dann wird der Kolben unter häufigem Schütteln bis zum Siedepunkt erwärmt.

5. Die bis zum Sieden gebrachte Suspension wird sofort einem Schwefelwasserstoffstrom ausgesetzt und im Verlaufe von 15 Min. zersetzt. Daraufhin vird der Kolbeninhalt ausfiltriert und durch das Filtrat ein CO_2-Strom bis zur völligen Entfernung des Schwefelwasserstoffes hindurchgeleitet*[3].

6. Aus dem erhaltenen Extrakt werden 50 cm³ genommen, in einen Masskolben für 100 cm³ gegeben, hierzu tropfenweise eine 20% $Pb(CH_3COO)_2$ Lösung bis zur völligen Ausfällung*[4] gegossen.

7. Diese Mischung wird 2—3 Min. lang mit Schwefelwasserstoff behandelt, vom PbS-Niederschlag abfiltriert, und durch das Filtrat nochmals ein CO_2-Strom bis zur völligen Entfernung des Schwefelwasserstoffs (Kontrolle auf restlose Entfernung!) hindurchgeleitet.

8. Die so erhaltene völlig farblose und durchsichtige Lösung wird zur Reaktion auf das Vitamin B_1 benutzt.

Die Reaktion geht folgendermassen vor sich:

In ein Probiergläschen werden gegeben 6 cm³ des Reaktivs von Kinnersley und Peters*[5], 2 cm³ diasotierter 0.5% Sulfanylsäure*[6], 3 Tropfen 40% Formaldehyds und sofort darauf 1 cm³ des zu prüfenden Extrakts. Der Inhalt des Probiergläschens wird schnell geschüttelt und dann auf 10 Min. in heisses Wasser (90—95°) gestellt, woraufhin es kolorimetriert wird.

Man kann vorher ein Skala für verschiedene Verdünnungen des Vitamins anfertigen und die zu beobachtende Färbung vergleichen.

Die Bestimmung nimmt 3—4 Std. in Anspruch und muss am selben Tag abgeschlossen werden.

---

*[1] Die Feuchtigkeit des zu prüfenden Objekts muss berücksichtigt werden.

*[2] Die Mischung wird unmittelbar vor dem Gebrauch hergestellt: zu 15 cm³ 25% Hg $(CH_3COO)_2$ werden 5 cm³ von 1% $PtCl_4$ hinzugefügt und sorgfältig vermischt.

*[3] Kontrolle mit Natriumnitroprussid.

*[4] Prüfung auf die Yolles'sche Reaktion.

*[5] 100 cm³ normaler NaOH-Lösung+100 cm³ 5.76% $NaHC_3$-Lösung.

*[6] Die Lösung der diasotierten Sulfanylsäure muss farblos sein. Gelbwerden derselben zeigt an, dass sie nicht zu verwenden ist.

Die Prüfung der einzelnen Momente der Methode wie auch die Standardiesierung für die Kolorimetrie werden in einer ausführlichen Untersuchung im Jahre 1936 in den «Arbeiten des Biochemischen Laboratoriums des Wissenschaftlichen Forschungsinstituts der Sowjetunion der nördlichen Kornwirtschaft und Kornbohnenkultur» veröffentlicht.

Zum Schluss möchten wir Prof. W. I. Towarnitzky für die Ratschläge und Hinweise, welche unsere Arbeit erfolgreich begünstigten, unseren tiefen Dank ausdrücken.

Biochemisches Laboratorium.
Wissenschaftliches Forschungsinstitut
für nördliche Kornwirtschaft
und Kornbohnenkultur.

Eingegangen
d. 28. VIII. 1936

ZITIERTE LITERATUR

[1] В. А. Девятнин и В. М. Дорошенко, Вопросы питания, № 5 (1935). [2] W. A. Dewjatnin u. W. M. Doroschenko, Biochem. ZS., **280**, 118 (1935). [3] W. A. Dewjatnin u. W. M. Doroschenko, C. R. Acad. Sci. URSS, III, № 4, 177—180 (1935). [4] G. Kinnersley u. R. Peters, Biochem. Journ., **28**, № 2 (1934), [5] Makino Kataschi u. T. Imai, Hoppe-Seyler's ZS. physiol. Chem., **239**, № 1—2 (1936). [6] В. А. Девятнин и В. М. Йосикова, Труды Центр. ин-та гематологии и переливания крови, вып. 16 (1936).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

GEOCHEMISTRY

ON THE ACTION OF SULPHIDE MINERALS ON SOLUTIONS OF GOLD AND PLATINUM SALTS

By O. E. ZVIAGINCEV and E. L. PISARŽEVSKAJA

(Communicated by N. S. Kurnakov, Member of the Academy, 31. VII. 1936)

In previous papers ([1], [2], [3]) it had been shown that small quantities of platinum were present in nearly all sulphide-bearing rocks. It had also been shown that platinum was mainly associated with galenite whenever the latter was present. In the absence of galenite, platinum is nevertheless present in the rocks, and is then associated with other sulphides.

This attitude of platinum to lead is somewhat astonishing, since the radii of their atoms are different, as also are the crystal lattices of their sulphides. It was imperative to find an explanation of this strange phenomenon.

The simplest way to account for it was to suppose that, chemically speaking, the attitude of galenite to platinum salt solutions differs from that of other sulphides. Experiments were therefore made to test the action of various sulphides on platinum salt solutions. Each of five glass jars was filled with 700 cm³ of a sodium chloroplatinate solution (Na_2 $PtCl_6$) of an initial concentration of about 1 g platinum per litre. All the jars were placed in a row on a table and were mixed with glass mixers. All the jars except one, which was to be used as a control jar, contained some sulphide, viz., galenite, sphalerite, chalcopyrite and pyrite respectively, as finely ground powders passed trough a sieve of 150 mesh. The analysis of the minerals is given in Table 1. All the mixers were driven by the same motor and the mixing went on for a long time (with brief intervals, which were equal for all the jars).

Table 1

Composition of the metals before experiment*

Galenite		Pyrite		Chalcopyrite	
Pb	77.13%	Fe	46.45%	Fe	34.67%
S	18.05%	S	52.01%	Cu	24.84%
				S	35.30%

One of the experiments showed that one month and a half after the beginning of the experiment the solutions had changed their colour. The determinations of platinum content in 10 cm³ of filtered solution gave:

10 cm³ of pure Na_2PtCl_6 solution		0.0119 g Pt
10 » » N_2PtCl_6 solution with galenite		0.0094 » »
10 » » Na_2PtCl_6 solution with pyrite		0.0118 » »
10 » » » »	» with chalcopyrite	0.0105 » »

Another experiment, which lasted a month, gave the following results:

10 cm	pure	Na_2PtCl_6	solution	gave	0.0109 g Pt
10 »		Na_2PtCl_6	solution	with galenite	**0.0095** » »
10 »		»	»	» sphalerite	0.0110 » »
10 »		»	»	» pyrite	0.0108 » »

A similar experiment was made with a solution of platinum chloride (H_2PtCl_6). The experiment lasted one and a half months whereafter an analysis of the solutions gave:

10 cm³	pure	solution	of	H_2PtCl_6	0.0090 g Pt
10 »	H_2PtCl	solution	with	galenite	**0.0036** » »
10 »	»	»	»	pyrite	0.0090 » »
10 »	»	»	»	chalcopyrite	0.0084 » »
10 »	»	»	»	sphalerite	0.0088 » »

An analysis of the precipitates after the reaction is given in Table 2.

Table 2

Composition of the precipitate after the experiment*

Galenite		Chalcopyrite	
Pb	39.65%	Fe	35.76%
S	21.72%	Cu	25.38%
Pt	21.34%	S	35.58%

* For the sake of clearness only the principal constituents are given.

The above data show that galenite reacts much more strongly with platinum solutions than do other sulphides. It may be seen from Table 2 that platinum sulphide is produced by the reaction, so that the reaction is one of exchange:

$$2PbS + Na_2PtCl_6 = 2PbCl + PtS_2 + 2NaCl.$$

In the experiments with H_2PtCl_6, the residue also contains some free sulphur.

The reaction of exchange with the other sulphides, i. e. the sphalerite and the chalcopyrite, proceeds much more slowly and is hardly noticeabe in the interval of time observed by writers. The pyrite failed to react altlo gether.

In addition to the chloroplatinate of sodium and platinum chloride, we also made a few experiments with a chloride solution of Reise's first base $[Pt(NH_3)_4]Cl_2$. No reaction, however, was noticeable after a month.

For a comparison with the action of sulphide minerals on platinum salt solutions, we made some experiments on the action of the same minerals on a gold chloride solution, in identical conditions. These confirmed fully Palmer and Edson data(4), viz.: sulphides reduce gold back to metallic gold, pyrite and chalcopyrite acting rapidly, and galenite slowly.

Institute of General and Inorganic Chemistry.
Academy of Sciences of the USSR.
Moscow.

Received
31. VIII. 1936.

REFERENCES

[1] O. E. Zviaghintsev, W. W. Lebedinsky, A. N. Philippov, C. R. Acad. Sci. URSS, Nouvelle Série, No 4 (1933). [2] O. E. Zviaghintsev et A. N. Philippov, C. R. Acad. Sci. URSS, I, No 2—3, 130 (1935): сб. «Большой Алтай», I, 191 (1935). [3] O. E Zviaghintsev a. A. N. Philippov, C. R. Acad. Sci. URSS, I, No 23, 136 (1935). [4] Palmer a. Edson, Bull. Amer. Inst. of Min. Eng., 1843 (1913).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

GENETICS

THE DATA ON THE STRUCTURE OF THE TESTES OF HYBRIDS OF YAK AND CATTLE

By A. I. ZUITIN and V. V. IVANOVA

(Communicated by A. A. Sapehin, Member of the Ukrainian Academy, 16.VIII. 1936)

Five years ago the senior author published data on the histological analysis of the testes of hybrids between yak and cattle(5). According to his observation the spermatogenesis in a ½-bred yak (F_1) is nearly always absent being confined to the formation of spermatogenial cells and in a $^1/_4$-bred yak (F_2 from backcross) it stops at a more or less advanced stage of primary spermatocytes. Insufficient material on hand forced the author at that time to estimate these results with great precaution.

Owing to work of the junior author, W. W. Ivanova, we have now at our disposal some additional data that together with the previous results are given in the table below.

It was suggested that an investigation on a large scale of the material in question will reveal the correspondingly greater variety of structures within the testes of both the ½-bred and the $^1/_4$-bred hybrid males. The present investigation, however, showed that it is not the case; all the hybrids studied revealed a very similar picture of the disturbance of the normal course of spermatogenesis.

The differences observed between the separate testes within the same degree of heterozygosis are only quantitative in nature and can be found not only in the same testes but in the same preparation also.

Therefore, the revision of this question on the new material did not essentially change the picture already described in 1930.

In this connection M. Zawadoswky's data (4) concerning the hybrids between yak and zebu seem to deserve great interest. The ½-bred (F_1) hybrid males as well as the $^1/_4$-bred (F_2) were found to be sterile like those in our own investigation.

As far as the study of successful preparations of one of these $^1/_4$-bred males showed the great majority of seminal tubules do not contain developing spermatozoa at all, and only in few of them the spermatogenesis continues approximately up to the stage observed in our $^1/_4$-bred yak. This similarity confirms once more the great relationship of cattle (aurochs) and zebu and emphasized at the same time the typical features of the spermatogenesis described above for $^1/_4$-bred yaks.

More interesting in this relation is our material on two $^3/_4$-bred yaks (F_2 from F_1 hybrid female to full-blooded yak), the analysis of it is given below.

No	Degree of heterozygosis	Age	Locality of castration and fixing	Date of castration and fixing
1	$\frac{1}{2}$ bred yak	2 years	Kirghisian Republic	23.VIII.1928
2		$2^1/_2$ »	Oyrotyja	30.VI.1930
3		$6^1/_2$ »	Kirghisian Republic	30.XII.1932
4		$1^1/_2$ »	Oyrotyja	5.X.1933
5	$\frac{1}{4}$ bred yak (F_2 from F_1 × full-blooded bull)	3 »	Kirghisian Republic	23.VIII.1928
6		$2^1/_2$ »	Oyrotyja	30.VI.1930
7		$2^1/_2$ »	»	5.X.1933
8	$\frac{3}{4}$ bred yak (F_2 from F_1 × full-blooded yak)	$2^1/_2$ »	»	30.VI.1930
9		$2^1/_2$ »	Kirghisian Republic	30.XII.1932

The spermatogenesis in a $^3/_4$-bred yak reaches a much more advanced stage when compared to $^1/_4$-bred hybrids and leads in a few isolated regions of the seminal tubules to the formation of mature sperm normal in appearance, although we cannot assert their normal physiological condition i. e. their capability for movement and fertilization.

An information concerning microscopic observation of the semen of a $^3/_4$-bred yak obtained at the time of castration was kindly presented to us by J. M. Lubimov*. The spermatozoa so far as could be examined under the microscope were immobile. However, the analysis of the semen was carried out in both cases under such circumstances that might have caused the immobility of spermatozoa.

The mature sperm appear sporadically in small amount (from a few single spermatozoa to several tens of them) and are arranged in narrow regions as shown by the cross sections through the seminal tubules. In this respect these tubules are very different from those pertaining to full-blooded grown animals. Amongst the rare tubules containing spermatozoa there are exceptionally some richer in the sperm. In such cases spermatozoa are arranged more or less evenly arround the lumen of tubules, resembling the structure of seminal tubules in the full-blooded animals. These exceptional tubules of the hybrids can be compared as to the quantity of germinal cells with the pure species.

---

* The writers are very much indebted to J. M. Lubimov for submitting to us kindly these data.

The picture of the spermatogenesis in both our $^3/_4$-bred yaks renders very little probable Wohltmann's assertion (3) concerning the sterility not only of $^3/_4$-bred but also of $^7/_8$-, $^{15}/_{16}$- and $^{31}/_{32}$-bred yaks which were obtained by Kühn in the Agricultural Institute at the University of Halle.

One can surmise that there are some reasons in sharp critical remark noted by Lotsy [(1), p. 37] who studied the material on hybridization and criticized his work for the absence of a system in the crosses.

Thus, according to the pictures found spermatogenesis in a $^3/_4$-bred yak is intermediate between a $^1/_4$-bred and a full-blooded yak as well as a $^1/_4$-bred yak is intermediate form between a $^1/_2$-bred and $^3/_4$-bred hybrids. Since F_2 ($^1/_4$- and $^3/_4$-bred yaks) shows the greater variability of the spermtogonial features as compared to F_1 ($^1/_2$-bred yak), this phaenomenon is to some extent parallel to Lus' findings (2) concerning the variability of morphological characters in hybrids females; F_1 females are very uniform in appearance, while $^1/_4$-bred and $^3/_4$-bred hybrids show segregation, as far as we can judge by the small amount of material.

There should be no need to point out that we do not necessarily expect a strict parallelism between the amount of variability in traits of spermatogenesis, on the one hand, and in morphology of the hybrids, on the other.

Laboratory of Genetics of
the Leningrad University.
Institute of Genetics.
Academy of Sciences of the USSR.

Received
16.VIII.1936

REFERENCES

[1] J. P. Lotsy, Genetica, IV, 32—61 (1922). [2] Я. Я. Лус, Материалы КЭИ Академии Наук СССР, вып. 21, 149—227 (1930). [3] F. Woltmann, Kühn-Archiv, I (erster Halbband), 1—59 (1911). [4] М. М. Завадовский, Тр. по динам. развит., VI, 221—240 (1931). [5] А. И. Зуйтин, Изв. Бюро по генет., № 3, 77—89 (1930)

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

PLANT PHYSIOLOGY

NEW FACTS IN SUPPORT OF THE HORMONAL THEORY OF PLANT DEVELOPMENT

By M. CH. ČAJLACHJAN

(Communicated by A. A. Richter, Member of the Academy, 28.VIII.1936)

The dependence of the morphogenesis of shoots on processes occurring in the green leaves, the transfer of this influence from leaf laminae into the growing points, and the specificity of the changes determining the development of plants in distinction from their growth,—such are the basic facts that permit us to come to a conclusion that the process of plant development is hormonal in nature ([1], [2]).

By upsetting the correlations between the growing point of the shoot and the leaf that are usual in the quite normally developing plant it has been shown that the action of the factor hastening development becomes localized only in case the system: leaf—growing point of shoot, comes within the limits of its action. If, after clipping, only leaves be left at one end of the plant and only shoots with their growing points, at the other, then there arise between them the same relations as in normal plants, since the blossom hormones produced in the leaves move into the growing points. As our experiments have shown, this movement of the blossom hormone is limited neither by intervening distance nor the direction of movement.

On the basis of these facts, which pointed toward the hormonal nature of the developmental processes, we conducted further experiments with *Perilla nankinensis*, *Helianthus tuberosus* and *Helianthus, annuus. Perilla nankinensis* is a decorative plant with wrinkled leaves of dark red color in pairs on the main stem. At the latitude of Moscow this plant does not blossom under the conditions of the full natural day. If perilla be cultivated under the conditions of an artificially shortened day (10 hours day) then it quickly bursts forth with numerous clusters of small pink blossoms. The following experiment with perilla was undertaken. Plants reared under the condition of the long summer day were used; they were grown in clay vases in usual garden soil. At the beginning of the experiments the plants were in a state of vegetative growth; large numbers of leaves were formed on the main stems. A part of the plants were used as stocks; on these stocks tops of other vegetating plants were grafted. The grafts were made as following: the top of the stock was cut off and the upper part of the decapitated stem was split in two for a distance of about 8 centimeters. On each of the tops used as

scions there were left 2 small leaves at the growing point. Each top was then cut so as to form a wedge, inserted into the split of the stock and wrapped. After the end of the operation the plants were kept for 5 days in a room with high humidity under the conditions of a full natural day. During this period the grafted tops took to growing. After 5 days the plants were transferred to a greenhouse and divided into two groups.

The plants of the first group were totally left for the whole time in the natural day, so that they differed from normal plants only in having engrafted tops from other plants (control grafts). In the second group the tops (scions) were likewise left in the natural day (i. e. under the same condi-

Fig. 1.

tions as before the grafting); but the stocks were kept in the conditions of a short 10-hour day. The artificial shortening of the day was accomplished by the following means. Broad funnels made of wire rings surrounding the plants were constructed in the clay vases. The upper rings reached the level where the grafts were made. From 6 p. m. till 8 a. m. these funnels were wrapped with covers made of two layers—the inner one of black cloth and the outer one of white cloth. These covers were tightened just below the points of the grafts.

The basic idea of the experiments was to direct the blossom hormone forming in the leaves of the stocks, subjected to the short day, into the growing points of the engrafted vegetating tops.

Twenty days after the operation the stocks subjected to the short day began to put forth fruit shoots. From some of these stocks such fruit shoots were stripped off, but on others they were left. Twenty-nine days after the beginning of the exposure to the short day the stocks began to flower.

At first no difference was observed between the tops (scions) of the control plants and those grafted on stocks of the short day. In both groups leaves appeared which were continuously stripped. But soon the picture changed completely. The tops grafted on stocks whose fruit-shoots were stripped began to form their own fruit-shoots and to blossom. The flowers apperead on them 10 days later than on their stocks. The tops grafted on stocks which maintained their fruit-shoots continued vegetative growth and did not differ from the control ones.

Fig. 1 shows the plants during the period when the covering took place. On the left is a control graft subjected to the full day; the top is not flower-

ing. On the right are two operated plants the stocks of which were equally subjected to the short day; the top of one of them is flowering, while the top of the other is not. This last difference is explained by Fig. 2, where the covers are removed. Only the top (scion) is flowering, that was grafted to a stock of the short day from which all lateral shoots were continuously stripped.

This experiment shows that together with nutrient substances there is a movement of blossom hormone from the leaves of the stock into the growing points of the engrafted top, where they cause formation of flowers.

The blossom hormone begins to move when the natural centers which usually attract it are removed. As such natural centers act the shoots located in the leaf axillae of leaves, producing the blossom hormone. If these

Fig. 2.

shoots with their growing points are left in the leaf axillae, most of the produced blossom hormone moves into these shoots and does not reach the scion.

In an experiment with *Helianthus tuberosus* and with *Helianthus annuus* we carried out the same investigation as with perilla. *Helianthus tuberosus* in the latitude of Moscow does not bloom, owing to the too long day of the summer period. As our experiments showed, it may be made to put forth flower buds and bloom by artificially shortening the day. We might here have proceeded in the same manner as in the case of the perilla, but the facility with which *Helianthus tuberosus* can be grafted on the sunflower made it feasible to take the Early Saratov sunflower, which blossoms well in the latitude of Moscow, as a stock.

On May 5th sunflower seeds were sowed in pots and in somewhat larger pots the tubers of the red *Helianthus tuberosus*. The sunflowers came up May 29th and the *tuberosus* June 1st. At the end of June, the sunflower began to form flower buds and heads and by July 8th they were quite large and on some specimens were beginning to burst into bloom. On July 8th, the vegetative tops of *Helianthus tuberosus* were grafted on the flowering-stage sunflowers. Two or three leaves were left on the *tuberosus* tops right at the growing points, the lower end being cut off wedge wise and set into the split sunflower stalk; the tops of the sunflower bearing the head of lorets were first cut off. On part of the decapitated sunflower plants, buddings

were made: i. e. the *tuberosus* buds were set in a T-shaped incision in the skin of the sunflower. At the same time control grafts of *tuberosus* tops were made on decapitated *tuberosus* plants. The controls were 4 in number and the experimentals, 20.

After keeping the plants operated on in a humid room and after transferring them to the greenhouse, side shoots with flower buds appeared in the leaf axillae of the sunflowers; they were stripped off. In both experimental and control graftings, the grafts survived well and grew vigorously.Thirty

Fig. 3.

days from the time of the operation,—that is, on August 15th, formation of flower buds began on the tops of *tuberosus*, both on those engrafted and those budded—vegetative growth had given way to reproductive development. On the tops of *tuberosus* grafted on *tuberosus* (control grafts) vegetative growth continued, with constant formation of leaves.

In the experiments with the sunflower and *tuberosus*, there was no need to resort to a special regime of lighting in order to produce the blossom hormone in the leaves of the stock. The fact of the flowering of the sunflower shows that at the latitude of Moscow the production of the blossom hormone takes place intensively in its leaves under natural conditions and that this blossom hormone may be made to reach the growing points of engrafted *tuberosus* tops. The production of such a movement of the hormones is dependent on the stripping of the growing points (of lateral shoots) off the stock itself, that is, the sunflower, since they would otherwise prove centers of attraction for the blossom hormones elaborated in the sunflower leaves.

This experiment shows that the blossom hormone is not specific in its action for separate plant species, but has the same nature in different plants.

The production of the blossom hormone in leaves exceeds its outflow; hence an accumulation of a certain part of the blossom hormones takes place in the leaves. This is indicated by special experiments with the perilla. The perilla plants beginning to bloom in the short (10 hours) day on June 19th were decapitated and all their fruit shoots were stripped off; the plants were then removed to the full natural day. From buds formed anew there grew shoots with flowers which at first differed nowise from ordinary fruit shoots. But after the lapse of some time, leaves instead of flowers began to appear on the

shoots, at first, small and misshapen, then larger and having the form of the usual leaves of the vegetating plant. In Fig. 3 are shown photos of three shoots (July 28) cut from the plants. The shoot on the extreme right, quite typical of plants that have been subjected the whole time to the short day, have formed flowers and fruit and are beginning to die. The shoot on the left is taken from a plant that had begun to bloom on June 19th and which, after being stripped of all its fruit shoots, was afterward subjected to the full natural day. The significance is unmistakeable: the formation of flowers proceeded so long as the supply of blossom hormones, accumulated while it received the short day, was not exhausted. After this supply was used up, the plant resumed vegetative growth. If this plant were again placed under a short day regime, that is, under conditions favoring the production of blossom hormones, it would pass from this beginning vegetative stage to the formation of flowers again. The middle shoot was, indeed, cut from a plant that had been subjected to the short day up to June 19th, and then, from that date to July 7th, to the full day, and from July 7th to July 28th, to the short day again.

The nature of the blossom hormone, its physical and chemical characters, are as yet unknown to us, but its action the direction of its movement, its general nature for different plant species and the implications of its quantitative accumulations, make it now possible to concentrate attention on a study of its internal nature.

Having this in view, we may term this blossom forming or blossom hormone, more concisely, florigen, meaning «blossom-former», which expresses the basic function of this substance in the vegetable organism.

The flowering of a plant begins as a result of the production in the leaves of a sufficient quantity of florigen. In the leaves of flowering and fruiting perennials there is a great quantity of florigen which, it may be, might be used in gardening and fruit growing for the purpose of hastening the flowering and fruiting of young seedlings. Such a method of using florigen might be the grafting of young seedlings, either by budding or graft, on the top of fruiting trees—widely practised by selectioners-fruit growers. But grafting, of itself, will give no results so long as the blossom hormone, florigen, is not directed from the leaves of the stock into the engrafted shoot. To this end, it is necessary to preserve all the leaves on the stock branch when grafting and to strip off all shoots both those present at the time of grafting and those that form later.

Institute of Plant Physiology.
Academy of Sciences of the USSR.
Moscow.

Received
28 VIII 1936.

REFERENCES

[1] M. Ch. Čajlachjan, C. R. Acad. Sci. URSS, I, № 2, 85—90 (1935). [2] M. Ch. Cailachjan, C. R. Acad. Sci. URSS, III, № 9 (1936).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

ZOOLOGIE

KASPISCHE PERAKARIDEN IM MANYTSCH-BASSIN

Von A. L. BEHNING

(Vorgelegt von S. A. Zernov, Mitglied der Akademie, d. 31. VII. 1936)

Prof A. O. Tauson aus Perm, welcher 1935 das in den Gewässern des unteren Don und Manytsch von der Nord-Kaukasischen Fischerei-Station gesammelte hydrobiologische Material (I. J. Syrowatskij) bearbeitet hat, übersandte mir zur genaueren Bestimmung einige Gläschen mit Peracarida.

Das Material war im Frühling (Mai, Anfang Juni) bei allgemeinen ichthyologischen Untersuchungen in dem Stromgebiet des unteren Don und Manytsch (Station Manytscht und oberhalb davon) gesammelt worden und enthielt 5 Parakaridenarten.

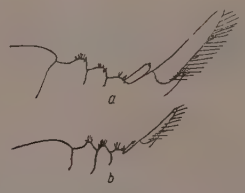


Fig. 1. Höcker des I. und 3. Urussegmentes bei *Pontogammarus aralensis*. *a*—♂ × 23; *b*—anomales ♀ × 33.

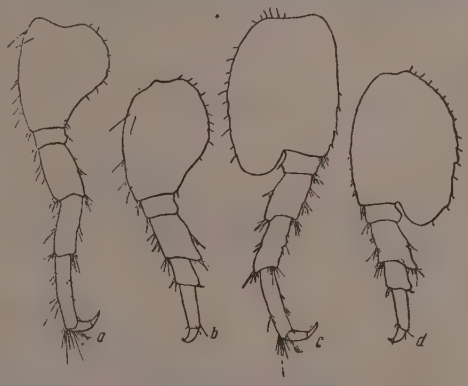


Fig. 2. *Pontogammarus aralensis*, ♀. *a*—VI. rechte Extremität; *b*—dieselbe linke; *c*—VII rechte Extremität, *d*—dieselbe linke, ×43.

Amphipoda

1. *Pontogammarus aralensis* (Unljan).

a. Fl. Manytsch, zwischen dem Altwasser Uzlovatyi und der Station Manytsch, 30. V. 1935: 1 ♀ und 2 juv.

b. Fl. Manytsch beim Altwasser Bystrjanskij, 2. VI. 1935: 1 ♂, 1 ♀.

Die Manytschexemplare, unter welchen sich 2 erwachsene Weibchen und 1 Männchen befanden, sind von geringer Grösse, 7—7.5 mm, welche der von Martynov (3) für die Dontiere angegebenen entspricht. Auf den relativ hohen und breiten Höckern der 1. und 2. Urussegmente (Fig. 1*a*, und *b*) be-

finden sich 5—6 Stacheln und einige Borsten, welche teils gerade nach oben, teils fächerartig nach allen Seiten gerichtet sind. Die erste Antenne besteht aus 13 (♂) und 11 (♀) Gliedern, die Nebengeissel—aus 3 Gliedern; bei der 2. Antenne sind 6 Glieder.

Das Weibchen aus der zweiten Probe zeigt eine interessante Anomalie in der Gestalt der zwei letzten Brustbeine der linken Seite (Fig. 2, *b* und *d*). Im Vergleich zu den normalen Beinen der rechten Seite (*a* und *c*) sind diese beiden Extremitäten (*VI* und *VII*) etwas kürzer, schwächer beborstet und endigen mit einem dickeren und kürzeren Dactylus. Endlich ist bei beiden Beinen das distale Aussenende leicht verlängert, über die Basis des nächsten, fünften Gliedes hinaus reichend. Eine derartige Verlängerung des vierten Gliedes dieser Beine findet sich bei keiner Art dieser Gattung, kommt jedoch bei anderen Gammariden (z. B. bei *Pseudalibrotus*) vor. Wahrscheinlich haben wir es hier mit einer Regeneration dieser beiden Beine zu tun, welche bei dem Tier in der Jugend teilweise oder auch ganz zerstört waren.

2. *Chaetogammarus tenellus* (Sars.)

a. Fl. Manytsch, zwischen dem I und II Altwasser, 7. V. 1935: 1 ♀ von 6 mm.

b. Fl. Don, 9. V. 1935 (St. 38 I): 1 ♂ von 8 mm.

3. *Corophium curvispinum* Sars.

Fl. Don, 9. V. 1935 (St. 38 I): 1 ♂ von 6.5 mm.

4. *Corophium bidentatum* Sars.

Fl. Don, 9. V. 1935 (St. 38 I): 1 ♀ mit Eiern von 7 mm.

Martynov ([3]) führt für den unteren Don *C. curvispinum*, *chelicorne* und *maeoticum* an.

Mysidacea

1. *Limnomysis benedeni* Czern.

a. Fl. Manytsch am Altwasser Bystrjanskij, 2. VI. 1935:2 ♂ (7—9 mm), 2♀ (6.5—7.5 mm).

b. Fl. Manytsch, zwischen dem Altwasser Uzlovatyj und der Station Manytsch, 30. V. 1935: 1 ♂ von 8.5 mm.

Das Auffinden dieser Perakariden im Manytsch ist von Interesse und erfordert eine weitere Untersuchung (in Anbetracht der eben vorgenommenen Don-Manytsch Kanalarbeiten), namentlich des Oberlaufs des Manytsch, besonders der zahlreichen gegenwärtig isolierten Gewässer dieses Flusssystems. Ein Auffinden von Kaspiseekrebsen (vielleicht auch einiger anderer Vertreter der alten Kaspiseefauna) in diesen Gewässern wäre von nicht geringem Interesse, zumal vor kurzem Birstein ([2]) dieselben ebenfalls in isolierten Gewässern des unteren Terek entdeckt hat. Im Zusammenhang damit erklärt der Verfasser dieses Vorkommen daselbst als ein aktives Eindringen dieser Krebse und rechnet sie, ebenfalls wie auch die übrigen pontokaspischen Elemente unserer Flüsse und Seen, ausser der Aralychfauna in Armenien, zu den Immigranten. Ohne hier eine Kritik an dieser Ansichten des genannten Verfassers weiter zu üben, sei nur hervorgehoben, dass ich 1927 [([1]) S. 122—124] ausführlicher meine Ansicht über diese Frage ausge-

sprochen habe (die Wolgarelikte), und denke, dass es auch heute noch richtiger ist, in solchen Fällen von Relikten und Pseudorelikten (im Sinne Ekmans) zu sprechen, nicht aber von Immigranten. Zu letzteren rechne ich solche Tiere, welche imtande sind, aktiv aus dem Meer ins Süsswasser zu wandern, und welche diesen Übergang sozusagen vor unseren Augen dokumentieren (wie z. B. die Wanderfische, *Eriocheir sinensis* u. a.). Der Übertritt aus dem Salzwasser und Brackwasser in die Süssgewässer unserer pontokaspischen Formen verlief in der Hauptsache in früheren geologischen Perioden, im Zusammenhang mit den Transgressionen der südlichen Meere, welche hier stattfanden. Die Tatsache einer weiteren Ausbreitung (auf aktivem oder passivem Wege) eines sich im neuen Millieu (in unserem Falle also eines Meeres- oder Brackwasserbewohners im Süsswasser) akklimatisierten Organismus wurde m. E. von niemandem angezweifelt.

Zoologisches Institut.
Akademie der Wissenschaften der UdSSR.
Leningrad.

Eingegangen
d. 31. VII. 1936.

ZITIERTE LITERATUR

[1] A. Behning, Die Binnengewässer, V (1928). [2] Я. А. Бирштейн, Зоол журн., XIV, 4 (1935). [3] А. В. Мартынов, Ежегодн. Зоол. муз. Ак. Наук, XXV (1925).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

ZOOLOGY

THE LAKE FORM OF ONCORHYNCHUS NERKA FROM LAKE KRONOTSK, KAMCHATKA

By E. M. KROCHIN and F. V. KROGIUS

(Communicated by S. A. Zernov. Member of the Academy, 4. V. 1936)

Great interest, of recent years, has been attracted by the acclimatization of anadromous *salmonidae* in fresh waters. This question has a special interest for Kamchatka, which has no fresh water ictchyofauna of industrial importance. However, before embarking upon acclimatization, it would seem advisable first to study the forms already naturally acclimatized, in order to ascertain the changes that take place in the fish when it is transformed from an anadromous form into a fresh water one.

In 1909 P. J. Schmidt, chief of the zoological section of Riabushinski's Kamchatka Expedition, discovered a small fish in Lake Kronotsk «similar», as he wrote, to a young *Oncorhynchus nerka* (1). Inasmuch as anadromous salmon do not visit Lake Kronotsk, there naturally arose the supposition of the existence in it of lake forms of *Oncorhynchus nerka*. In a number of North American lakes lake forms of *Oncorhynchus nerka* have been discovered and are known in the literature under the name of *Onc. nerka Kennerlyi*; Chamberlain (2) mentions its presence in lakes Alturas, Walawa, Seton, and others. Moreover, Mitsukuri (3) states that lake *Oncorhyncus nerka* were found in Lake Akan-ko on the Hokaido island and transferred from there to a number of other Japanese lakes (Shikotsu, Onuma, Towada). Until the present time, the supposition as to the existence in Lake Kronotsk of lake forms of *Oncorhynchus nerka* remained unproved; in order to clear up the matter, an expedition was organized in the spring of 1935 by the Kamchatka Station of the All-Union Institute of Fisheries and Oceanography under the leadership of E. M. Krochin. Besides definitely setting the existence of lake forms of *Oncorhynchus nerka* in this lake, the expedition has also taken the task of studying Lake Kronotsk itself, which had been, up to that time, essentially an unknown body of water (suffice it to say that, not only was its morphology, thermics, chemism, and so forth, unknown, but that even the outlines of the lake were differently represented on various maps).

The study of *Oncorhynchus nerka* was carried out by setting nets under the ice at various depths and in various parts of the lake; during the whole stay of the expedition at the lake (from April 21 to May 21), we succeeded in taking only 6 specimens of *Oncorhynchus nerka*.

Below are shown the data on the time and place of catches of *Oncorhynchus nerka* in Kronotsk Lake.

Table 1

Place of catch	Date 1935	Depth of the lake at place of catch in metres	Depth of catch in metres	Ground	Temperature °C	Number of fishes taken
Kamchadal Bay, about 1 km from the shore .	25/IV 27/IV	21	About 20	Mud	1.8	1 1
Unfrozen patch before source of Kronotsk River	6/V 11/V	3	About 2.5	Sand	1.4	1 1
Unan Bay, unfrozen patch before mouth of Unan River	16/V 17/V	4	About 3	Mud with sand and detritus	1.5	1 1

The small number of fish taken maybe the result of lack of acquaintance with the places where schools of *Oncorhynchus nerka* gather or else of the smallness of their number in the lake (the latter we consider as being more likely).

The size, age and rate of growth of *Oncorhynchus nerka* are shown in the following table (length according to Smitt in cm).

Table 2

Age group \ Years	1	2	3	4	5	6
4 years	7.0	12.5	17.0	20.3	—	—
	7.9	13.2	17.9	20.4	—	—
5 »	7.6	13.5	18.3	22.6	24.7	—
	10.6	16.1	20.0	22.5	24.7	—
	8.2	14.5	21.1	24.1	27.8	—
6 »	9.0	13.3	18.6	22.5	25.5	28.0
Average	8.4	13.8	18.2	21.7	24.9	28.0

As is to be seen from the table, the size of the fish varied from 20.3 to 28.0 cm*; the age, from 4 to 6 years.

In the graph (p. 92) is shown the rate of growth of the Kronotsk *Oncorhynchus nerka* (—); for comparison there are presented likewise the growth rate of the anadromous *Oncorhynchus nerka* from Lake Kuril, which lives one (....) or two (— — —) years in fresh water before its migration into the sea. The straightness of the curve of growth rate of the Kronotsk *Oncorhynchus nerka* is quite typical for the non-anadromous fish. It is evident that, untill their migration into the sea, the anadromous fish grow just as do those that stay in the lake. After descent into the sea, the anadromous *Oncorhynchus nerka* abruptly increases its growth rate and quickly leaves the lake form behind, the latter continuing to grow at the same rate— which accounts for the straightness of its growth-rate curve. At the end of 5 to 6 years, the lake form is only half the size of the migrating form.

* That is, near to the size found by Gunther (4) for *Oncorhynchus nerka Kennerlyi* (10—11 inches).

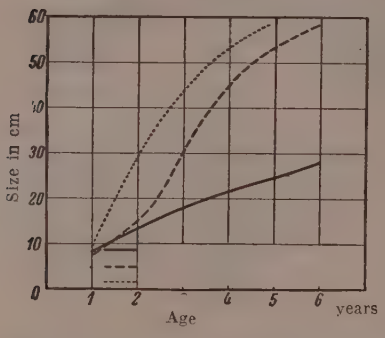
A comparison of the plastic and meristic characters of the lake form and of the anadormous *Oncorhynchus nerka* from Dalneye Paratunskoye Lake is shown in Table 3.

Table 3

Characters	Kronotsk Lake (lake form)		Dalneye Lake (anadromous form)	
	M	Range of variation	*M*	Range of variation
Length according to Smitt	24.3	20.3—28.0	55.6	47.2—62.2
Number of gill rakes	33	29—36	36	32—38
» » » rays	12	11—13	14	13—16
» » scales in lateral line	127	122—133	138	130—144
Number of rays in *D*	III—9—10	—	II—V—9—11	—
» » » » *A*	II—III—13—14	—	II—IV—12—16	—
» » » » *P*	1—14—15	—	1—13—16	—
» » » » *V*	II—9	—	I—II—9—10	—
In percentages of body length				
Length of body without *C*	94.3	93.7—94.5	—	—
» » trunk	73.9	71.2—76.8	74.3	71.2—77.6
» » head	21.2	19.8—23.0	21.9	19.1—24.6
Greatest depth of body	21.1	20.3—22.2	20.9	19.1—24.0
Smallest » » »	7.4	7.1—8.1	6.9	6.1—7.5
Greatest thickness of body	10.0	9.3—10.7	—	—
Antedorsal distance	43.6	41.8—46.2	44.5	40.6—47.2
Anteventral »	48.0	47.4—51.7	48.6	45.2—52.7
Anteanal »	67.2	64.8—68.8	66.9	65.0—69.9
Length of caudal peduncle	16.0	14.6—16.6	16.5	14.9—18.1
Length of base of *D*	9.6	8.3—10.3	10.4	9.2—12.6
Height » » » *D*	11.9	11.3—12.9	11.6	9.3—13.5
Length » » » *A*	11.8	11.3—12.6	11.5	10.1—13.0
Height of *A*	9.7	8.0—10.7	8.9	8.0—10.4
Length » *P*	15.0	12.8—16.2	14.1	12.8—15.9
» » *V*	12.3	11.8—12.5	11.4	9.1—13.9
» » upper lobe of *C*	18.0	16.2—19.6	15.6	14.0—16.9
» » middle rays of *C*	5.5	4.9—6.5	6.0	5.1—7.0
In percentage of length of head				
Length of snout	22.9	20.2—25.0	30.1	25.2—38.5
» » » from beginning of the *maxillare*	12.6	10.6—14.3	18.9	12.9—27.2
Horizontal diameter of eye	18.2	15.1—19.4	11.6	9.4—14.4
Vertical » » »	18.5	15.1—20.4	10.9	8.9—12.8
Postorbital part of head	53.8	51.0—59.5	54.5	49.1—59.2
Height of head at the occiput	70.7	68.0—73.8	68.8	60.0—77.0
Height of head through middle of the eye	50.3	44.7—54.8	47.5	42.5—55.4
Width of forhead	32.5	29.8—34.7	35.6	31.9—38.7
Length of maxillary bone	40.0	39.3—42.8	41.3	36.5—46.8
Width » » »	6.8	6.0—7.9	7.4	5.7—9.1
Length of lower jaw	63.1	57.5—66.6	—	—

N o t e. Averages and ranges of variation are calculated for males and females; figures for fishes from Dalneye Lake are calculated on the basis of 100 specimens, those for Lake Kronotsk, on the basis of six specimens measured.

On the basis of this table it can be said that the Lake Kronotsk *Oncorhynchus nerka* differs from the anadromous form by the smaller number of scales in the lateral line, by a greater minimum depth of the body, by a longer snout, by larger eyes, by a higher and narrower head and by smaller dimensions of the *maxillare*; the rest of the characters scarcely differs in the two forms. Of the six specimens of lake *Oncorhynchus nerka* taken, five were males and one a female; in May, the sexual products of these fish were in the stage 1—2.



As the table shows, the *Oncorhynchus nerka* was taken only in the bottom layers, at a depth of about 20 metres; at smaller depths it was taken in unfrozen patches (polynias) before the source of the Kronotsk River and the mouths of rivers emptying into the lake. The temperature of 1.5° was characteristic of the place of catch: at this time of the year, this temperature is found at a depth of 20 metres or in polynias. Investigation of the contents of the stomachs of two specimens showed that the principal food of the lake forms was adult *Copepoda* and *Ostracoda*.

S. S. Smirnov investigated the stomach contents of the specimen of the Lake Kronotsk *Oncorhynchus nerka* and found the following: 1) *Gammaridae*, 2 specimens, 2) *Cyclops gigas*, 5 specimens, 3) *Harpacticoidae*, 1 specimen+ +1 fragment, 4) *Simulidae*, scraps, 5) a digested mass.

On the basis of all this, the Lake Kronotsk *Oncorhynchus nerka* may be described as a fish feeding on the inhabitants of the bottom layers and, to a less extent, on the botton organisms.

The spawning of the lake forms, according to the hunters of the locality, is very late—in December; the places of spawning are to be found in certain rivers emptying into Lake Kronotsk and, according to the hunters, spawning goes on in the same way as with the anadromous forms.

The expedition defined Lake Kronotsk on the map with considerably greater accuracy and made measurements of the depth along five profiles. This work showed that Lake Kronotsk, in area the largest volcanic lake of Kamchatka (212 sq. km), is considerably less in depth than another volcanic lake of Kamchatka, Lake Kuril (75 sq. km); the maximum depth found by the expedition in Lake Kronotsk was 128 m, while the maximum depth of Lake Kuril is 306 m. The greatest depth lies near the Bera island, which rises in the form of a peak from the lake bottom. Investigation on the distribution of temperature showed a relatively great drop of temperature to occur before freezing of the lake. In this respect, also, Lake Kronotsk differs from Lake Kuril, in which, as we demonstrated in April and May, 1933, only the upper layers of 5 to 10 m, undergo a great drop of temperature.

Institute of Fisheries and
Oceanography.
Kamchatka Station.

Received
4. V. 1936.

REFERENCES

[1] П. Ю. Шмидт, Камчатская экспедиция Рябушинского, зоол. отд., вып. I, 124 (1916). [2] F. M. Chamberlain, Rapp. Bur. of Fish., 627 (1907). [3] K. Mitsukuri, Bull. Bur. of Fish., XXIV (1904). [4] Gunther, Catalogue of Fishes in the British Mus., VI, 120 (1866).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

ZOOLOGY

CHARACTER OF THE PROPAGATION OF CERTAIN RODENTS AS A FACTOR OF THEIR NUMBER IN NATURE

By G. M. RALL

(Communicated by S. A. Zernov, Member of the Academy, 17. IV. 1936)

The propagation and dying out of rodents was, rather recently, subjected to a many-sided study in both laboratory and nature, which resulted in a number of valuable works by the Soviet zoologists B. Vinogradov (1), P. Sviridenko (4), N. Kalabuchov (3), A. Formozov (6) and others, works which considerably enhanced our understanding of these ecologically complicated problems.

The potentially unlimited prolixity of the rodents is checked by the resistance offered by thier physico-biotic environment (death rate). The interaction of these two processes results in a yearly fluctuation in the number of individuals in the population of positively all species of rodents *(Glires)* just as with other animals. But, while the squirrels *(Sciurus)* (5), the *Muridae* (1,4), the *Leporidae* (4) have a very high variability, the numbers of the *Marmota* (5), *Citellus* (2) *Dipodidae*, and others, fluctuate within comparatively narrow limits. Among the latter species, «outbursts» of propagation, such as are observed, for example, among the *Muridae* and which entail overwhelming calamity in the economic activities of men, are unkown. It follows that a change in one and the same factor, death rate*, leads to a different variability of this or the other population and that by this factor it is impossible to explain the underlying characteristics of the dynamics of the numbers of the two groups mentioned above.

Turning now to the second factor—propagation—we see that simplicity of the generative processes of a population stabilizes its role in biocenosis, while complexity of those processes produces (and in its turn is conditioned by the whole external environment) an extreme instability of a given group among the surrounding organisms, where it holds now a quite dominating position, now a very subordinate one.

In what follows I utilize the original data on 10 649 individual rodents that were systematically studied in the Volga-Ural sandy semi-desert (surrounding the Novo-Ushtagan anti-plague station, Jungalin District, Western

* The likelihood of death is quite variable from year to year and depends on the numbers of predatory animals, the intensity of epizootia, climatic and biocenotic factors.

Kazakhstan) since the year 1932 by M. Demyashev, M. Šeikina and the author, the zoologists of the Saratov Institute of Microbiology and Epidemiology.

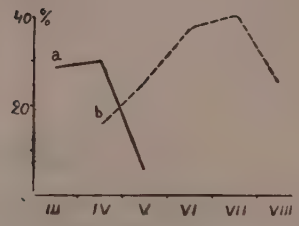


Fig. 1. *a*—Curve showing the presence of pregnant females in the population of *Citellus pygmaeus* Pall.; *b*—same for *Dipus sagitta innae* Ogn.

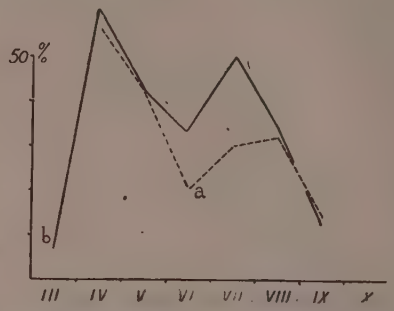


Fig. 2. *a*—Curve showing the presence of pregnant females in the population of *Meriones tamaricinus* Pall.; *b*—same for *Pallasiomys meridianus* Pall.

The generative period of a population may be characterized by the percentage it contains of pregnant females as well as by its content of suckling young. These data are shown in the table (p. 95) and are illustrated in Figs. 1, 2 and 3 (where, to save space, only the pregnancy curves are drawn).

I shall begin with the population of *Citellus pygmaeus* Pall. (Fig. 1, *a*). Awakening from hibernation (in this district between March 15 and 31) about 30% of the females become pregnant, and the generative period closes

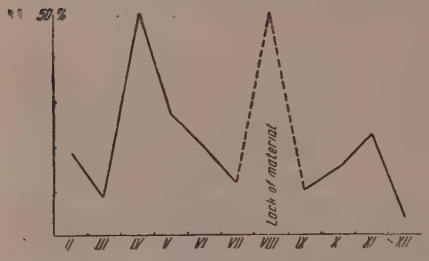


Fig. 3. Curve showing the presence of pregnant females in the population of *Mus musculus wagneri*. Eversm.

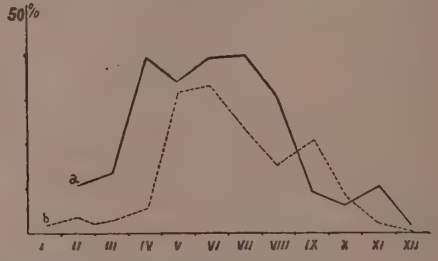


Fig. 4. Percentage curve showing the presence: *a*—of pregnant females. *b*—of young individuals in the complex consisting of *C. pygmaeus*, Pall., *D. sagitta* Pall., *M. tamaricinus* Pall., *P. meridianus* Pall., *M. Musculus* L.

abruptly about the middle of May. The fact that one and the same female litters only once during the season of active life and the non-participation of the young in propagation render the generative processes among the susliks quite simple.

The generative processes of *Dipus sagitta innae* Ogn. (Fig. 1, *b*) is the first step towards complexity. A certain number of adult females bear second litters and there are known cases of littering even by subadult females. The

Table

Data on the Generative Periods of Certain rodents during the Years 1932—1935 (The data on *C. pygmaeus* Pall. are for the years 1932—1933—1934 only; on *D. sagitta* Pall. for 1932 and 1935)

Months	*Citellus pigmaeus* Pall.				*Dipus sagitta innae* Ogn.				*Meriones tamaricinus* Pall.				*Pallasiomys meridianus* Pall.				*Mus muskulus wagneri* Eversm			
	Total	Sexually mature females dissected	Of which pregnant	Young individuals	Total	Sexually mature females dissected	Of which pregnant	Young individuals	Total	Sexually mature females dissected	Of which pregnant	Young individuals	Total	Sexually mature females dissected	Of which pregnant	Young individuals	Total	Sexually mature females dissected	Of which pregnant	Young individuals
I	—	—	—	—	—	—	—	—	33	7	—	—	295	92	—	—	164	49	—	1
II	—	—	—	—	—	—	—	—	14	5	—	—	176	36	—	—	175	52	10	13
III	107	35	10	—	5	2	—	—	12	1	—	—	181	28	2	—	169	59	5	5
IV	309	127	38	5	25	12	2	—	66	16	9	—	213	48	30	14	102	14	7	25
V	245	56	3	106	75	36	8	9	179	62	26	10	643	107	43	241	56	11	3	11
VI	166	26	—	58	122	48	18	18	189	30	6	70	626	70	23	239	66	10	2	5
VII	130	2	—	—	161	47	19	46	181	54	16	42	542	83	41	171	114	8	1	6
VIII	196	3	—	—	227	64	16	60	184	50	16	23	502	117	40	84	15	2	1	1
IX	6	—	—	—	261	70	—	45	155	35	5	13	658	177	21	187	84	10	1	—
X	—	—	—	—	175	40	—	9	268	61	—	13	738	114	—	98	366	146	22	10
XI	—	—	—	—	18	—	—	—	117	10	—	—	498	94	—	12	296	107	24	8
XII	—	—	—	—	—	—	—	—	36	11	—	—	227	55	—	—	191	88	3	11
Total	1.059	249	51	169	1.069	319	63	187	1.434	342	78	171	5.299	1.021	200	1.046	1.798	556	79	96

population of *D. sagitta innae* Ogn., considered as a peculiar ecological group, is a link between *Citellus*, with its long winter hibernation and short period of propagation, and the *Muridae*.

In the generative period of the *Merione tamaricinus* Pall. a two peaked percentage curve of pregnant females is quite marked (Fig. 2,*a*). The second maximum of pregnancy is due not only to a second breeding of the adult females but also to the inclusion of subadults in the process. Even a third pregnancy was observed in some of the adult females. However, the death rate of breeding animals in nature is very high. The bulk of females die before or after the first breeding.

The phenomenon described above is especially marked in the population af *Pallasiomys meridianus* Pall. (Fig. 2, *b*), where the propagation by subadult females is more frequent than in the case of *M. tamaricinus* Pall. (thus, out of 177 subadult females of *P. meridianus* Pall. investigated in 1935 75—43.2% were found breeding), while cases of second and third littering of adult females are also quite frequent. Owing to the high death rate of breeders that has been mentioned, the great majority of females do not bear second, third, etc. litters, and the second maximum of pregnancy is due, for the most part, to propagation by subadult females.

Finally, in the population of *Mus musculus wagneri* Eversm., the periods of maturing and the periods of pregnancy are quite short; therefore, the mice, despite the forces that make for their destruction, succeed in bringing forth several litters during the protracted generative period (Fig. 3). In nature (under usual conditions), the number of litters probably is not more than 4 or 5. The prompt and frequent participation of the young in breeding also contributes to the complexity of the generative processes, as a whole, of these rodents. Such a process, in its pure and potential aspect, has been studied by P. Sviridenko ([4]).

The material presented correlates the biological nature of the propagation of certain rodents with the variability of their numbers and sheds light on the great role of this factor in the life of a population.

It is not without interest to use these data in yet another general aspect. I characterize the generative period of all the five species mentioned by percentage curves showing the presence of pregnant females and young individuals (Fig. 4). The rise of the curve of pregnancy in spring is due to susliks; the autumn rise is due to mice, as is correspondingly reflected by the curve of the appearance of the young. It would be quite interesting to compare these data for a group of rodent species with, for example, those for a group of predatory species in order to be able to form an idea of the difference in the processes of propagation of these animals.

Saratov State Institute
of Microbiology and Epidemiology.

Received
17. IV. 1936.

REFERENCES

[1] Б. Виноградов, Матер. по динамике фауны мышевидных грызунов СССР, изд. СУ ОБВ (1934). [2] Н. Калабухов, Тр. по защ. раст., сер. IV, вып. 2 (1932). [3] Н. Калабухов, Зоол. журн., XIV, вып. 2 (1935). [4] П. Свириденко, Тр. по защ. раст., сер. IV, вып. 3 (1934). [5] А. Формозов, Колебания численности промысловых животных (1935). [6] «Экология сурка», Внешторгиздат (1935) (symposium).

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

EXPERIMENTAL ZOOLOGY

INFLUENCE OF VARIOUS FACTORS ON MORPHOGENESIS* FOLLOWING HOMOTOPICAL SUBCUTANEOUS INSERTIONS OF CARTILAGE IN THE AXOLOTL

By N. V. NASSONOV, Member of the Academy

In the article «The Role of Cartilage in Formations in Axolotls» (Nassonov, 1935), I showed that when cartilage is inserted under the skin of the leg of axolotl, processes occur at the place of inserting the cartilage similar to the regenerative process which ensues upon amputation of a leg, and that, besides, there are additional formations. In the present paper I intend briefly to set forth certain results of my investigations into the influence on morphogenesis of various factors when a homotopical insertion of cartilage is made under the skin of the axolotl.

The investigations were conducted principally on 6 to 11 months old black axolotls. In each series, cartilages from different parts of the leg were mostly inserted into the auto, zeugo- and stylopodia separately. The best results were obtained from auto- and zeugopodia. Altogether, 786 insertions were made of comminuted portions of cartilage.

As in former experiments, the pieces of cartilage were inserted together with a certain amount of connective tissue which remained on the cartilage after preparing it. In order to show that morphogenesis might occur without the participation of the perichondrium, a number of insertions were made of cartilage excised from inside the articular head of the femur. By these cases one might be convinced that pure cartilage is also capable of producing additional formations.

A series of 74 insertions of normal cartilage into the legs gave 13 additional formations (17.5 per cent) in which digits with cartilaginous phalangues could be seen plainly marked, and 14 embryonic formations without differentiation of the digits.

The principal traits of the development of additional formations when cartilage is inserted under the skin are described in my article mentioned above (Nassonov, 1935) and indicate that the cartilage functions as an organizer**). Firts of all it must be supposed that the cartilage causes the disap-

* In these articles I substitute the word «formation»—used in my preceding articles—for the word «morphogenesis»

** I have found that insertion under the skin not only of cartilage but of other tissues, as, for example, the tissues of the wall of the lung, causes the formation of additional parts of the leg. Thus, parts of the lung and of certain other organs may act as organizers. This fact will be treated in one of the following articles.

pearance of the cutis at the place of its insertion—that is the disappearance of a hindrance to morphogenesis. For brevity I term the substance acting in this manner coriocide. Next there are indications of the existence in cartilage or in its products of disintegration of a number of organizing substances. Tending toward the formation of the initial stages of the development of additional extremities, there are in them, apparently, substances stimulating the multiplication of epithelial cells and regulating this proliferation so as to form an epithelial embryo of the extremity, as also substances causing the appearance of mioblasts (Nassonov, 1935). Further, I consider that in cartilage there is a substance which probably participates in the formation of a cartilaginous skeleton, and which I have called chondrogen. This is confirmed by the fact that this substance is contained in an aqueous extract from cartilage, since, according to my observations, this extract transforms the subcutaneous connective tissue in a culture *in vitro* into cartilage (Nassonov, 1935). Besides these, there are, in all probability, a number of other organizing substances in cartilage.

Boiled cartilage failed in 70 cases to give any formations when inserted under the skin of the legs. This, it seems to me can be explained by the fact that, aside from chondrogen, which, as we know, is soluble in water (Nassonov, 1934) there are also, perhaps, certain other organizing substances in cartilage that are soluble. Another reason for the suspension of morphogenesis may lie in the action on the cartilage of the increased temperature. This was elucidated by the following experiments. 118 insertions of leg cartilage heated to 100° C in a moist medium were made subcutaneously in various parts of the legs. In these cases, too, no such additional formations resulted. Sections made 18, 30, 57 and 119 days after the subcutaneous insertion of cartilage that had been heated to 100° showed that the skin was unchanged and that the cutis had remained entire in contrast to what occurs when normal cartilage is inserted, which, as we know, acts in such a way as to destroy the cutis. Apparently, the substance which acts in such a manner on the cutis and which we have named coriocide does not form when the cartilage has been heated to 100°, or else is changed. It is probably due to this that the skin remains unchanged. We also know that the skin covering the wounds prevents the regenerative processes at their very beginning (Tornier, Godlevsky, and others). Hence it must be supposed that the skin in this case, through remaining unchanged, gives no possibility of the development of an additional formation, when cartilage that has been heated to 100° is inserted beneath it.

The loss of the capacity of cartilage to produce morphogenesis occurs also at lower temperature than 100°. When heated to 45 and 35° eighty insertions of cartilage gave no morphogenesis, and destruction of the cutis did not occur. Cartilage heated to 30° and inserted under the skin produces primitive formations in the aspect of smallish tubercles which disappear shortly afterwards.

Cooling of cartilage to 0° does not destroy its capability of producing morphogenesis, but lowers it considerably. Forty insertions of cooled cartilage were made. From none of them a differentiated extremity or part of an extremity was obtained. Ten formations that resulted were only excrescences of epitelium in the form of tubercles, cones and some flattened cylindrical undifferentiated formations up to 2 mm long. Sections showed that the cartilage preserves only the coriocide and the stimulators as well as the regulators of epithelium proliferation, as the cutis breaks

down and the excrescences are covered only by epithelium. Internally they consist only of connective tissue. When the cartilage was frozen to —10 or —15°, there occurred a complete loss of its capability of destroying the cutis, and morphogenesis did not occur.

All this suggests the idea that cooling to 0° weakens the action of the cartilage cells inserted under the skin, while freezing and temperatures over 30° kill them, and that the coriocide under ordinary conditions is excreted by the cartilage cells. But it argues against this supposition that, after the amputation of a leg and skin grafted on the wound, the cartilage produces no morphogenesis even though it be inserted under the skin.

Cartilage dried at 100 to 110° gave no definite formations at all when the cartilage were placed far enough from the edge of the wound through which the insertion was made, but if placed near the edge of the wound, then, on the wound itself, covered at first with epithelium and afterwards with cutis, were sometimes obtained quite primitive undifferentiated formations*. I obtained five of these two or three months after the insertions were made. Altogether 53 insertions were made, finely comminuted cartilage being used.

Formations of this kind have the aspect of tubercles similar to embryonic legs on their appearance during embryonal development, but sharply delimited at the foundations. I described such formations in my article «Formations Produced in the Axolotl by the Subcutaneous Insertion of Dried Regeneration Bud» (Nassonov, 1934, p. 326) and called them primitive digit-shaped formations. Their walls consist of skin with well developed cutis. Inside them are to be found connective tissues and blood vessels. Appearing at the edge of the wound, they are, at first, probably covered only with epithelium and then cutis forms in them, which probably grows from e edges of the wound. I suspect that here also, just as in the case of cartilage heated to 100° in a moist medium, the coriocide is absent, and this is the reason, why no formation occurs on the surface of the skin, while at the same time those organizing substances are to a slight extent preserved which stimulate the multiplication of epithelial cells in a certain direction, resulting in an elevation formed on the skin we saw at the beginning of the morphogenetical process, when normal cartilage was inserted under the skin (Nassonov, 1935). As we have already mentioned, in morphogenesis there are more substances than one that stimulate the growth of epithelium in a definite direction. (For example, in the case just cited, there appear embryonic formations in the form of cupola-shaped elevations.) As stated above, there are probably two or several substances, some of which may be called stimulators of multiplication of epithelial cells or, briefly, stimulators of epithelium, while others are regulators of epithelial growth through which it takes on a definite form. This is confirmed by the fact that, as we shall see in the next article, when leg cartilage of lizards is inserted under the skin of the leg of an axolotl, there plainly results only a stimulation toward multiplication of the epithelial cells, but no formation of the epithelial elevation of the embryo of additional leg parts. Apparently, for this latter process there are needed not only substances stimulating multiplication of epithelial cells, but regulating substances as well.

At lower temperatures dessicated cartilage preserves its capability of

---

* I failed to obtain these formations by inserting the cartilage near the edge of the wound, if it has been heated in a moist chamber up to 30—100°C. However, the impossibility of their obtaining under such conditions ought to be proved by further investigation I am conducting just now.

morphogenesis, but in a very slight degree. 29 insertions of cartilage, dried for two days at room temperature (16 to 21°) and 37 insertions, dried at 28 to 32° gave only three embryonic formations on the skin. Two were about 1 mm high, a cupola-shaped tubercle with a small cylindrical outgrowth at the top, while the other had the form of black scallops 1 mm wide and 0.5 mm high. Both contained microscopic cartilages showing through the skin. As sections revealed, all these cartilages have irregular shapes with outgrowths. It must be supposed that in the given case the coriocide, and to a very slight extent, the chondrogen, the stimulators and regulators of epithelial multiplication, had been preserved.

Experiments were also made on the influence of 95 per cent alcohol on leg cartilage. 40 insertions of cartilage that had been kept six days in such alcohol were made, 20 insertions of cartilage kept three days, and 80 insertions of cartilage treated in the same manner for two and one day. The latter experiment gave one two-pronged formation.

Out of 40 insertions of cartilage treated with ether for one day, there resulted one case of a smallish additional formation having two digits. But out of 40 insertions of cartilage treated with ether for 5 days and out of 25 insertions treated for 10 days, no accessory formations were observed; besides, the cutis maintained its integrity just as in insertions that had been subjected to alcohol. The formation at the first day of the additional extremities mentioned above may, it seems to me, be explained on the ground that in this case the ether and alcohol did not fully penetrate inside a large lump of cartilage. With a more prolonged action of the ether and alcohol, the treatment of the cartilage would probably have been more thorough. It would seem that treatment with strong alcohol and treatment with ether either dissolve the organizing substances or change them. The elucidation of these questions requires biochemical investigations.

Received 5.VIII.1936.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1936. Volume IV (XIII), № 2 (106)

EXPERIMENTAL ZOOLOGY

MORPHOGENESIS FOLLOWING HETEROTOPICAL AND HETEROPLASTICAL INSERTIONS OF CARTILAGE UNDER THE SKIN OF AXOLOTL

By N. V. NASSONOV, Member of the Academy

In my article Influence of Various Factors on Morphogenesis Following Homotopical Subcutaneous Insertions of Cartilage in the Axolotl», I showed that cartilage inserted under the skin may, in certain conditions, serve as an organizer in the formation of parts of that organ from which it was taken. In the present paper I intend briefly to treat of the influence of cartilage on morphogenesis following certain heterotopical and heteroplastical insertions of it under the skin of Axolotl.

The cartilage, just as in previous experiments, was taken together with the connective tissues and put, before being inserted, in Ringer's solution. 794 insertions were made.

Heterotopical Subcutaneous Insertions of Cartilage

Cartilage taken from the fore limbs can produce morphogenesis in the form of parts of legs when inserted under the skin of the hind limbs and, on the other hand, cartilage from the hind limbs can produce such morphogeneses in the fore limbs. Furthermore, these morphogeneses may be well differentiated. These morphogeneses may be produced on legs when insertions are made under the skin of cartilages of the anterior and posterior belts of the extremities, the cartilages of both belts being capable of producing additional formations on both fore and hind legs. Out of 49 insertions of cartilages from the belts of the extremities 5 formations had well differentiated digits (12.5 per cent) and 4 were undifferentiated.

Insertions of cartilages from the spinal column of the tail into the skin of the leg produced formations dissimilar to legs and comparatively few of them, there being only 5 formations out of 67 insertions. Two were of insignificant size and had the aspect of tubercles of irregular shape and three were very small lamellar or conical, somewhat flattened, projections of the skin which, with the passage of time, were found to have shrunk. One of them, the more developed one, was observed during auto-insertions and was about 1 mm long. It had a large rounded expansion on one side, at the top, which, on further growth shrank and curled up. From the base of this formation there extended an epithelial scallop about 1.5 mm long. The expanded base

of these formations, as sections showed, was filled with connective tissue. Over a smallish area of the base the cutis was absent.

All were obtained on axolotl, after the insertion of cartilages taken from 9 months to 1½ years old axolotls. Consequently, in view of the little study that has been given to the phenomena under discussion, it might have been suspected that the insignificant result and the dissimilarity with the legs were due to the insertion in each separate case, of a scanty amount of cartilage that had been obtained from the skeleton of the tail of an axolotl of such age that it had already begun to ossify on the surface. Therefore, I inserted under the skin of legs of 34 axolotls (age 12 months) cartilage lumps of somewhat larger size, taken from the tail of young individuals about 8 cm long, in whose tails there was no skeletal ossification. Yet even in this case, only three embryonal, undifferentiated formations resulted, less than 1 mm high, two of them having a conical form and one an irregularly lobular form.

The results from the insertion of cartilage from the spinal column of the tail into the leg showed that coriocide as exists in the cartilage of the leg is to be found to a more slight extent in this cartilage or in the products of its decay, and that there are stimulators of epithelial proliferation and regulators of this proliferation for the formation of an epithelial embryo of the extremity, but there seem to be absent any other organizing substances forming the leg. Hence, it seems to me, it may be concluded that the cartilage of the spinal column differs in its chemical composition from the cartilage of the extremities and their belts.

On inserting cartilage from the legs under the skin of the tail, formations result that are similar in outward aspect to the tail. Out of 60 such insertions, not one formation resembling a leg resulted. They appear at first in the aspect of tubercles. A large part of them appeared in the middle part of the tail. 10 insertions of leg cartilage into the base of the tail behind the cloacum gave no results. Out of 40 tubercles that appeared, 18 ones, increasing in size, flattened out so that their flat side was parallel with the frontal plane of the body, and took on a more or less tail-like form. After varying intervals of time, the majority of them were reduced. Two of them held on longest, namely 77 days; they had the aspect of tail-shaped appendages of up to 1 cm in length. They shrank and curled up on top. Sections showed that they consisted, inside, of loose friable connective tissue. Such appendages did not atrophy, but fell off.

In these experiments we see that cartilage taken from the leg cannot produce additional formations possessing in any degree whatever the characteristic elements of the structure or form of the legs. Probably this results from the fact that when the cartilage was placed in the tail, there were not, in the surrounding tissues, the materials needed for the building up of legs. Thus, for a definite morphogenesis, the presence of the organizing substances that condition its appearance, is not enough; there must also be definite materials surrounding it.

In addition to this, leg cartilage does not appear to possess all the organizing substances that are required in the formation of a fully-developed additional tail. In my opinion, this would account for the fact that, when leg cartilage was inserted under the skin of the tail, what resulted was not a fully-developed tail, but only a tail-like formation. It is also possible that in morphogenetic processes an important part is played by the peculiarities of composition not only of the cartilage, but also of other tissues. Some of them, as will be seen hereafter, contain organizing substances.

In certain places in the body of the axolotl insertion of leg cartilage produces no morphogeneses. No results were obtained from 127 insertions of leg cartilage in the back and in the head. The cutis on the back is thicker than on the legs and at the age at which the axolotl were taken for experiment reaches 1 mm in thickness, whereas on the legs 0.25 mm is the maximum. In view of this fact, the thought struck me that thickness of the skin might have an influence on the absence of morphogenesis; accordingly I made 50 insertions of cartilage from the legs of 9-month and 1½-year axolotls into the back of a young axolotl about 8 cm long. Negative results were obtained. 40 insertions of cartilage from the head into the leg also gave negative results.

When leg cartilage was inserted under the skin of the sides of the trunk, there resulted only embryonic formations in the aspect of tubercles, or smallish conoid or tongue-shaped outgrowths about 2 mm long, which soon shrank. Such formations resulted in 5 cases out of 58 insertions. Further, 40 insertions of leg cartilage were made into the sides of younger about 8 cm long axolotl with negative results.

Further investigation, principally a biochemical one, is needed to explain these phenomena, just as in other cases when, following heterotopic insertions, the cartilage causes no formations. In this case, besides investigation of the chemical composition of the cartilage, a study of the chemical composition of the cutis may have great importance, especially, of its colagenic fibrils in various places on the body. Unfortunately, just as in the case of cartilage, they have received absolutely no attention in this connection amongst the various groups of vertebrate animals.

Heteroplastic Subcutaneous Insertions of Cartilage

With respect to heteroplastic insertions, I shall at present dwell only on the results obtained from insertions under the skin of axolotl of cartilage from animals standing philogenetically higher than *Urodela*, namely certain representatives of *Anura*, *Reptilia* and *Mammalia*.

Cartilage was taken from the articular head of the tibia and from the epiphysis of the shin and foot of the frog (*Rana esculenta*); 52 insertions were made under the skin of the leg of the axolotl. Seven morphogeneses (13 per cent), resulted in the form of one-, two- and three-pronged appendages. These formations were similar to those obtained when axolotl leg cartilage is inserted under the skin of the leg of the same animal. They contain a skeleton in varying stages of development, and muscles may also be formed in them. Thus, it may be supposed that the cartilage of the frog contains coriocide, also chondrogen, a stimulator of epithelium, a regulator of its proliferation substances influencing the formation of mioblasts, and other organizing substances contained in the cartilage of the axolotl, indispensable for the formation of the above-mentioned forms. But despite all this, regenerative processes do not take place in the frog after its metamorphosis. This leads to the belief that frogs' lack of the capability of regenerating the extremities depends above all else on their cutis, which is not broken down by the coriocide in frog cartilage, although this coriocide does break down the cutis of the axolotl. The cutis would seem to be one of the principal factors hindering the inception and development of morphogenetical processes. Confirmation of this is to be seen in the fact that a number of insertions of axolotl cartilage under the skin of frog legs did not produce additional formations. It

is possible, too, that this is in any degree due to the character of the composition of the tissues of the frog surrounding the axolotl cartilage. The working out of this question is not yet finished and further observations are being conducted.

Fifty pieces of cartilage were taken from the cartilage of the epiphysis of the legs of young lizards (*Lacerta agilis*). After they were inserted under the skin of leg of axolotl there ensued a destruction of the cutis and an extraordinarily strong stimulation of epithelial cell proliferation. The epithelium grew on the skin surface in irregular projections, sometimes of considerable dimensions, similar to canceroid growths of epithelium. These projections were levelled with the passage of time. Here we see that there are coriocide and stimulator of epithelial proliferation in the cartilage of the lizard, but that there are no other organizing substances for giving form to the epithelium, so that even those embryonic morphogeneses do not result which may develop, as we have seen above, from the insertion under the skin of the axolotl of dessicated cartilage or cartilage from the spinal column of its tail.

Sometimes lizard cartilage inserted under the skin of the leg of the axolotl was forced out through the skin like a foreign body.

With respect to insertions of mammal cartilage under the skin of the axolotl, 50 insertions of cartilage from the articular head of the femur of rat were made and 47 insertions of cartilage from the nasal septum.

There were also made 50 insertions of cartilage from rabbit ribs with the perichondrium and 40 insertions of cartilage without the perichondrium. In no case did morphogenesis occur; the cutis remained entire and there was no stimulation of epithelium.

In the case of the higher forms among the vertebrates best adapted to terrestrial life, such as the mammals amongst whom regeneration has almost completely disappeared, there has probably occurred either a disappearance of coriocide and, possibly, other substances the presence of which is necessary for the inception and development of morphogenetical processes, or else all these substances exist in such conditions that their action cannot for some reason be manifested in such processes. Further investigation will elucidate this problem.

A working out of the problem of the composition and of the absence of various organizing substances in various parts of the body, as also of their inception, change and disappearance during phylogenetical development, has very great importance toward an understanding of the phenomena of morphogenesis, in particular of regeneration and determination, to which belong the problems that we have had under consideration. It requires joint investigations of morphologists, cytologists and biochemists.

Received 5. VIII. 1936.

PRIX D'ABONNEMENT

Un an — 36 livraisons . . . . . $ 15
Six mois — 18 livraisons . . . $ 7.50
(Séparément $ 0.50 le numéro)
«Nouvelle Série» pour 1933 — 6 livraisons . . . $ 2
«Nouvelle Série» pour 1934 — l'année complète épuisée; volume III (9 livraisons) et volume IV (9 livraisons) en vente à $ 3 le volume.

URSS — Meždunarodnaja Kniga, 18, Kuznetskij Most. Moscou (Compte courant n° 263 Banque d'État de l'URSS, 12, Neglinnaja. Moscou).
NORTH and SOUTH AMERICA — BOOKNIGA CORPORATION. 255 Fifth Avenue. New York, N. Y.
GREAT BRITAIN — W. H. SMITH & son, Ltd. Strand House, Portugal °t London, W. C. 2.
FRANCE — MESSAGERIES HACHETTE. Service Abonnements. 111, Rue Réaumur. Paris, 2e.
SUISSE — Administration du Journal „LE TRAVAIL". 39, Rue de Lausanne. Genève.
ROUMANIE — Ig. HERTZ. Calea Victoria 5. Bucarest.
E. S. R. — MELANTRICH, Akc. Spol. Knihkupectvi — odd. slovanskych knih. Vaclavské nam 42. Praha II. (Ucet post. spor. 20. 208).
BELGIQUE — LIBRAIRIE P. DRIESSEN 38. Vieille Halle-aux-Blés. Bruxelles (C. C. P. 1861. 15).
CHINA — AMERICAN BOOK & SUPPLY Co 841 Bubbling Well Road. P. O. Box 1798. Shanghai.
HOLLAND — J. GINSBERG. University Bookseller. Kort Rapenburg, 17. Leiden
LIETUVA — „MOKSLA". Knygynas. Laisves Aleja, 46. Kaunas.
TURQUIE — LIBRAIRIE HACHETTE. Succursale de Turquie. 469, Avenue de l'Indépendance. Boite Postale Pera 2219. Istanbul.
DEUTSCHLAND — OTTO HARROSSOWITZ. Leipzig C I. Auerstrasse 14.
POLSKA — GEBETHNER & WOLFF. Filja 1. Krakowskie Przedm. 15 Warszawa.
ROSSICA. Chmielna 5. Warszawa.
KSIEGARNIA GIRSZOWSKIEGO. Zamkowa 13. Wilno.
JAPAN — NAUKA Booksellers No. 13. 2-Chome Jimbocho. Kanda Tokyo.
PALESTINE — SAFRAN Co Jaffa Rd. 36. P. O. B. 223. Haifa.
BULGARIA — T. F. TSCHIPEFF. Buchhandlung Boulevard Dondoukoff 20/22 Sofia. (Postscheckkonto-Sofia 540).

Les «Comptes Rendus», largement expédiés à l'étranger dans les centres scientifiques les plus importants et dans les bureaux de nombreuses revues, sont le seul organe scientifique en URSS, donnant tous les dix jours un compte rendu des plus récentes acquisitions de la science soviétique.

Prix — $ 0.50